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COMMITTEE ON THE PEACEFUL USES OF OUTER SPACE

SCIENTIFIC AND TECHNICAL PRESENTATIONS TO THE SCIENTIFIC AND TECHNICAL SUBCOMMITTEE AT ITS THIRTY-THIRD SESSION

Report by the Secretariat

1. During the thirty-third session of the Scientific and Technical Subcommittee, the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU) and the International Astronautical Federation (IAF) organized, in liaison with Member States, a symposium on the theme "Utilization of micro- and small satellites for the expansion of low-cost space activities, taking into account the special needs of developing countries", to complement discussions within the Subcommittee on that theme. This symposium was organized in accordance with the recommendation of the Subcommittee at its thirty-second session (A/AC.105/605, para. 136), which was subsequently endorsed by the Committee on the Peaceful Uses of Outer Space at its thirty-eighth session¹ and by the General Assembly in its resolution 50/27 of 6 December 1995.
2. The symposium was the twelfth to be organized by COSPAR and IAF during the annual meetings of the Scientific and Technical Subcommittee, the topic for each year being selected by the Subcommittee at the previous session. The symposium was held in two parts, on 12 and 13 February 1996, following the completion of debate in the afternoon meetings of the Subcommittee during the first week of its session.
3. In addition to these special presentations organized by COSPAR and IAF at the request of the Subcommittee, delegations of Member States provided a number of scientific and technical presentations by specialists in space science and applications relating to various items on the agenda of the Subcommittee. Several national and international organizations also made special presentations on their scientific and technical activities.
4. In order to make more widely available the information on recent developments in space science, technology and applications, presented during the symposium and the other presentations, the Secretariat has prepared a summary of that information, which is presented below.
5. The annex contains a more detailed description of the scientific and technical presentations made before the Scientific and Technical Subcommittee at its thirty-third session. The annex is in English only. A list of the presentations and the speakers is contained in the appendix to the annex.

I. SUMMARY OF PRESENTATIONS

Symposium on Utilization of Micro- and Small Satellites for the Expansion of Low-cost Space Activities, taking into Account the Special Needs of Developing Countries

6. It was stated that, in most developing countries, at least two categories of needs for small satellites and microsatellite systems could be identified. The first group might be classified as direct needs, related to social and economic problems that might be addressed through various applications of space technology. The second group of needs had an indirect nature and dealt with attaining the condition of taking full advantage of the country's investments in acquisition of space systems and services.

7. The use of Low Earth Orbit Communications (LEOCOM) systems allowed many services; one of the most interesting was the communication between a portable terminal and a normal telephone of the existing fixed telecommunication network. In that case, the two users might be located anywhere in the territory and particularly in remote areas or regions lacking a communications infrastructure. The communication between two mobile users as well as between a mobile user and a user of the fixed network system anywhere around the globe was also possible.

8. The use of automatic data collection platforms (DCP), in conjunction with the two-way characteristics of LEOCOM, allowed for installation of a data collection network that featured a wide coverage and provided real-time service. In addition, the LEOCOM system could provide the location of any user of mobile terminals with an accuracy in the 100 metre range. The LEOCOM mobile terminal could also be coupled to a facsimile machine for the transmission of graphical data. Thus, it allowed a user, for instance, to send a fax of an electrocardiogram in the case of a medical emergency in a remote area.

9. Telemedicine was an application that would increase efficiency of medical services by allowing the transmission of information obtained by inexpensive and simple sensors directly to complex processing units in large medical centres where it could be interpreted by specialized physicians. That would make it possible for powerful and effective emergency services to reach poor and undeveloped areas, saving many lives and avoiding unnecessary displacement of patients. The Healthsat project was a good example of telemedicine application that used a 60 kg microsatellite in Low Earth Orbit (LEO) to relay medical data information between Nigeria and North America. Mobile communication might also play an important role in cases of natural disasters, allowing help to reach the disaster victims earlier and providing logistical support to the rescue teams.

10. Many developing countries had had early access to the benefits of satellite remote sensing, but still had a long way to go in order to maximize the benefits of the existing capabilities. There were, however, unique needs at both national and regional levels that demanded new solutions. Brazil and the Republic of Korea, for instance, were already developing new satellite programmes to address their specific needs. Developing countries in Latin America, South-East Asia and in other regions required special sensor parameters such as spectral bands, spatial resolution, time resolution, cost of image, investment level in the ground equipment, and expertise required for utilization.

11. Cooperative space activities were often supported by some kind of technology transfer. A successful technology transfer in the development of the small satellite project implied a process by which a team acquired sufficient momentum to be able to produce the next generation of small satellites. There were several mechanisms whereby technology transfer could be achieved, but to be successful, the transfer should be a transfer of knowledge, not the transfer of a technology package (know-why as well as know-how). Examples of programmes where engineers from developing countries were trained on small satellite design, production and operations were numerous. The University of Surrey in the United Kingdom of Great Britain and Northern Ireland had, for example, provided such assistance in the development of small satellites below

100 kg to Chile, Pakistan and the Republic of Korea, and even to small countries in Europe that decided to initiate a space programme.

12. A small satellite project in Argentina, Scientific Applications Satellite B (SAC-B,) was being prepared in cooperation with the United States of America (Pegasus launcher). The main purpose of the project was to design a satellite with a scientific payload to advance the study of solar physics and astrophysics. The mass of the satellite was about 180 kg with an expected active lifetime minimum of three years. The launching of the satellite was scheduled for 1996. A new generation of satellites, SAC-C and SAC-D, aimed for scientific research and remote sensing, was being prepared for launching from 1999 to 2006.

13. In Brazil, great significance was attached to the collection of data from remote platforms using space technology. The Brazilian Complete Space Mission (MECB) was successfully started in February 1993 with the launch of the Satellite de Coleta de Dados (SCD 1). The satellite had remained operational two years after its expected useful life. At least two similar satellites would be launched to ensure continuity of the mission. In addition, the improved SCD 3 satellite (200 kg) would also be used in the mission to demonstrate the concept of voice and data communication in the equatorial region.

14. In Chile, the first operational satellite would be FASat-Bravo, developed in cooperation with the University of Surrey (United Kingdom). The 46 kg microsatellite would be put into circular orbit at 650 kilometres with an inclination of 82.5 degrees in August 1996. It would carry an ozone layer monitoring experiment, data transfer experiment, experimental Earth imaging system and some other equipment, including an educational experiment. Using the communications link provided by the satellite, students would be able to engage in study activities (orbital mechanics, satellite communications analysis, telemetry analysis etc.) one or two days per month.

15. The Satellite Research Center of the Korea Advanced Institute of Science and Technology (KAIST) began its programme to develop space technology with the launch of two scientific and experimental microsatellites, KITSAT 1 and 2, in 1992/93. Currently, KAIST was involved in designing its new indigenous satellite KITSAT 3 to enhance the capabilities of the previous two microsatellites. A primary objective of the programme was to develop a microsatellite system that had highly accurate attitude control, high-speed data transmission and the ability to provide hands-on experience to Korean space industries and research institutes. The remote sensing payload of KITSAT 3 would be able to monitor environmental disasters such as floods, volcanic eruptions and earthquake damages in the region of Asia and the Pacific.

16. In South Africa, the SUNSAT microsatellite project had been established in 1992 to increase engineering design opportunities for graduate students and to foster industrial and international interaction with Stellenbosch University. The 60 kg microsatellite would be able to provide images of cultivated fields, natural vegetation and pollution around the globe. The satellite would also be an electronic mailbox that would orbit the Earth to receive and deliver messages, as well as speech and data relay experiments to schools. SUNSAT should be launched by the United States Delta launcher in March 1997 into polar orbit at 450 to 850 kilometres, together with the Danish magnetospheric research satellite Oersted. SUNSAT would also carry the global positioning system (GPS) navigational receiver of the National Aeronautics and Space Administration (NASA) and a set of laser reflectors for precise positioning experiments.

17. A Spanish space project, MINISAT, was entrusted to the Instituto Nacional de Técnica Aeroespacial (INTA), Madrid by the Spanish Inter-ministerial Commission for Science and Technology (CICYT) in 1992. Modular satellites of 180 to 500 kg mass (depending on the number of modules used) would be launched by the Pegasus airborne launchers starting in 1996. The first satellite MINISAT 01 would consist of the basic platform and would be used for scientific research. Satellite MINISAT 1 would be an upgraded version, equipped for remote sensing observations and MINISAT 2 would use the basic platform to provide long-distance communications even from the geostationary orbit.

18. A small scientific sub-satellite MAGION 4 was launched on 3 August 1995 together with the INTERBALL 1 "mother" satellite. MAGION 4 separated from the mother satellite after reaching the planned orbit (apogee 191,907 kilometres, perigee 793 kilometres, inclination 63.0 degrees). The satellite had a mass of 60 kg and had been developed in cooperation by the Institute of Atmospheric Physics (Czech Republic), Technical University, Graz (Austria) and the Space Research Institute (Russian Federation). Its scientific payload was aimed at studying of the geomagnetic field, wave phenomena and plasma parameters of the ionosphere within the framework of the INTERBALL space project. Simultaneous measurements by two satellites at a small distance from each other allowed for temporal and spatial resolution of the observed phenomena.

19. The Central European satellite for advanced research (CESAR) was a spacecraft of about 300 kg planned for 1998 that would fly in an orbit with a perigee of 400 kilometres, an apogee of 1,000 kilometres and an inclination of 70 degrees. The scientific mission would be related to the study of the magnetospheric, ionospheric and thermospheric environment. Ten different experiments, provided by scientists from Austria, Czech Republic, Hungary, Poland and Slovakia, would be accommodated on board the spacecraft that was being constructed by the Italian Space Agency (ASI).

20. A working group on small satellites was created in the French space agency CNES at the end of 1993 to propose recommendations for the development of a series of small satellites complementing the Satellite Système probatoire d'observation de la terre (SPOT) system, at a cost of less than 300 million French francs per mission and a development time of two years. The recommended programme was called Plateforme reconfigurable pour l'observation, les télécommunications et les usages scientifiques (PROTEUS). The first flight was envisaged in 1999 as a continuation of the successful France-United States altimetric satellite project Topex-Poséidon.

21. The missions that were being considered by the Small Missions Opportunities (SMO) initiative of the European Space Agency (ESA) might be classified by the following parameters: 150-500 kg launch mass, orbit between 600 and 900 kilometres, development time of about two years, cost of less than 40 million European currency units for platform and integration, delivery on orbit, commissioning and user ground station. The basic concept of the SMO initiative was to have a common procurement of part or all of the following mission elements: launch, platform integration and ground segment. That approach should achieve the low-cost benefits for those recurrent elements of the mission.

22. In addition to the support (technological assistance and launching arrangements) provided to emerging space-faring nations, described in other parts of the present report, NASA had adopted its own Small Spacecraft Technology Initiative (SSTI). The technology programme should reduce the cost and development time of space missions for scientific and commercial applications. It should achieve a payload/total mass fraction of up to 70 per cent and times, from development to flight readiness, of two years. To achieve those goals, new design and qualification methods for small spacecraft should be demonstrated using commercial and performance-based specifications, integration of small instrumentation technology into the satellite bus design and end-to-end product development and flight verification. The future NASA mission capability should result in a 30-60 per cent reduction of costs and new technology insertion into missions.

23. NASA was also preparing a series of small, low-cost planetary science missions under its Discovery programme. They were designed to provide frequent investigative opportunities (one launch every 12-18 months) to the planetary research community, while encouraging partnerships with industry. All solar system targets and objectives were valid candidates for the Discovery programme, but the spacecraft cost should be low and the launch vehicle would be limited to Delta class or smaller. A total of 28 proposals were received in response to the first announcement of opportunity, covering the full range of planetary science objectives (the next announcement of opportunity was to be released in May 1996). The first four missions were fully funded, and their development was on schedule and within cost guidelines.

II. OTHER SCIENTIFIC AND TECHNICAL PRESENTATIONS

A. Space debris

24. Objects moving in the near-Earth space were regularly tracked and catalogued by the United States Space Command Space Surveillance System. That system operated more than 24 radar and several optical facilities to monitor near-Earth space and maintained a catalogue of orbital elements of all tracked objects (currently over 8,000). The minimum diameter of observable objects was about 10 centimetres for LEO and 1 metre for geostationary-satellite orbit (GSO). Objects in GSO were tracked mainly by the dedicated optical system Geosynchronous and Deep Space Surveillance (GEODSS). In addition, a special radar located at Haystack (near Boston, Massachusetts) was capable of detecting objects less than 1 centimetre in diameter in LEO and obtaining statistical information on number, flux, size and altitude. There seemed to be over 100,000 space debris in LEO at sizes down to 1 centimetre.

25. The largest radar tracking facility in western Europe at the Research Establishment for Applied Science (FGAN) in Wachtberg-Werthhoven (Germany) was using a 34 metre parabolic dish antenna. Data from that site were an important addition to the catalogue data in case of re-entry predictions for high-risk space debris. The ESA had sponsored research on the feasibility of detecting and tracking medium-size debris (1-50 centimetres). Regarding the debris measurement by optical telescopes, ESA would use a one-metre Zeiss telescope that was currently being installed at the Teide Observatory on Tenerife (Canary Islands, 28.3 degrees north latitude) for other purposes. The minimum size of detectable objects would be 2-6 centimetres in LEO and 20-40 centimetres in GSO. The telescope should be operational for space object observations at the beginning of 1997.

26. Information on particles smaller than about 1 millimetre was obtained mostly through special detectors carried by spacecraft or through the analysis of impacts on material that had been exposed to the space environment. Many European researchers had analysed impact features on the NASA long duration exposure facility (LDEF) after its retrieval in January 1990, on the European recoverable carrier (EURECA) spacecraft and on the solar array retrieved from the Hubble space telescope (HST). The largest hole diameters were about 5 millimetres. Results of these analyses would be used to validate the present reference flux models for small-size meteoroids and space debris.

27. Examination of windows, radiator panels and other surfaces of the United States space shuttle orbiters showed that environmental models underestimated microdebris population and that the population was growing with time. While the NASA space debris damage model Bumper predicted 13 window replacements in 12 shuttle missions, the actual number of replacements was 19. In France, additional data from one year of exposure to space environment on board the Mir station (ARAGATZ mission) were used for comparison with space debris environment models.

28. Unique debris hazards associated with the proposed satellite constellations had been studied in the United Kingdom. A satellite constellation was a distributed architecture of satellites that provided global positioning, Earth observation, hand-held personal communications, messaging or data transfer. There were proposals for a large number of new systems, which would mean that over 1,000 new satellites would be placed into high inclination orbits at altitudes of 700-800 kilometres and 1,200-1,400 kilometres within 4-6 years. Realization of such projects would result in concentrations of satellite mass at certain regions of space around the Earth.

B. Use of nuclear power sources in outer space

29. A numerical analysis related to possible collisions of nuclear power sources (NPS) with space debris had been performed by the Russian Federation. The following contingencies had been examined in particular: destruction of NPS structure; change of orbital parameters of NPS after collision; their entry into the

atmosphere; possible atmospheric destruction; and fallout of radioactive toxic material particles and parts of NPS structure. Collisions with space debris had been considered for reactors launched in the period 1970-1988 and injected into orbits within the altitude range of 700-1,000 kilometres. The probability of collisions with space debris, capable of considerable NPS damage, was sufficiently high and reached one in over 55 years.

30. Research on aerodynamic destruction of NPS and of the fuel rod assembly during their descent into the atmosphere after collision at the initial re-entry trajectory (altitude: 160 kilometres) confirmed that the NPS structure was destructed and the reactor fuel pins (uranium-molybdenum alloy) melted down to particle dimensions of less than 1 millimetre. The results had shown that fallout of such nuclear fuel particles, allowing for uranium fission product decay at the moment of collision, would not lead to a significant change in the radiation levels over the fall-out territory. The fall of the beryllium reflector parts and partially failed radiation shield of lithium hydride might constitute a threat from the point of toxicity, which would prompt search and clean-up (removal) measures.

31. In the United Kingdom, studies continued on possible supplements to the Principles Relevant to the Use of Nuclear Power Sources in Outer Space, adopted by the General Assembly in its resolution 47/68 of 14 December 1992. While the resolution included valuable consensus agreements on topics such as consultation, assistance to States affected by an accident, liability and compensation, it suffered from a number of limitations. Among those were the exclusion of propulsion and extraterrestrial bases; their formulation in terms of particular technologies; ignoring the potential effects of space debris; and inconsistencies with the more mature safety principles developed for the terrestrial applications of nuclear power. Therefore, a revision was suggested which generalized the intentions embodied in General Assembly resolution 47/68 in a way that was consistent with subsequent international developments under the aegis of the International Commission on Radiological Protection (ICRP) and the International Atomic Energy Agency (IAEA).

C. Remote sensing

32. With the successful design, development, launch and in-orbit performance of the first generation of the Indian remote sensing satellite (IRS), India was surging ahead to provide improved and enhanced data services from the second generation remote sensing satellites, IRS-1C and IRS-1D. IRS-1C, which was launched on 6 December 1995, was characterized by an improved spatial resolution, extended spectral bands, stereo viewing and faster revisit capability. Besides cartographic applications, the IRS-1C mission mainly addressed the following areas: crops and vegetation applications with specific reference to mixed crops and vegetation discrimination; biological parameters and oceanographic applications, in particular observations of physical oceanographic parameters such as winds, sea surface temperature, waves etc.; and atmospheric applications for monitoring global changes such as the depletion of the ozone layer over the Antarctic region.

33. The space research activities in Morocco, related to remote sensing and environmental monitoring, were characterized by an active, realistic and long-term policy at both the national level (coordination, information, training and project formulation) and the international level (participation in forums, international committees and bilateral and multilateral projects). The use of outer space in Morocco was becoming ever more developed, extensive and diversified. With regard to satellite data, stations were currently in operation to receive METEOSAT weather satellite data, for example, at the National Department of Meteorology (DMN). There were plans to set up two National Oceanic and Atmospheric Administration (NOAA) stations, one for meteorological studies at DMN and the other at the Royal Centre for Spaceborne Remote Sensing (CRTS) of Morocco for receiving advanced very high resolution radiometer (AVHRR) data. This station was to be set up within the framework of the GLOVE project, which was co-financed by the European Community.

34. GEOSPACE, a company located in Austria, was conducting a global mapping project to produce a digital atlas of the world. The global satellite image mapping project aimed to develop a global geographic

information system, which was easy to use, cost-effective and easily accessible for frequent updates. Studies were being performed at the local, regional and international level.

35. The status of new commercial remote sensing satellites was reviewed by the Secretary General of the International Society for Photogrammetry and Remote Sensing (ISPRS). These new satellites were intended to provide high resolution data, up to 2-5 metres, in the fields of meteorology, cartography, natural resources and commercial imaging. Countries that, in the recent past, had been involved in the development of such commercial remote sensing satellites were France, Germany, India, Japan, Russian Federation and United States. Furthermore, ESA was playing a major role in the development of new remote sensing satellites. An outlook for the next decade indicated that 99 Earth observation satellite payloads were planned to be implemented, of which 57 payloads should be established within the next five years. The new payloads would play a significant role in the development towards digital photogrammetry and remote sensing.

D. International Space University

36. The International Space University (ISU), established in 1988, placed emphasis on an interdisciplinary, international and intercultural space education programme. ISU contributed to the development of professionals required in the international space arena, such as creators, innovators, managers and leaders. ISU was dedicated to the education of professionals of all disciplines in space-related fields, the creation and expansion of knowledge through research, and the exchange and dissemination of knowledge and ideas.

37. During the course of the summer session programmes of ISU, comprehensive lectures were provided in all space-related disciplines and their interactions. Furthermore, an international space project was designed during the summer curriculum, resulting in a professional report with practical utility for the international space community. In addition to the summer session programmes, ISU had recently launched a Master of Space Studies programme, held at Strasbourg, France. The one-year graduate programme comprised three major elements: (a) sciences and applications; (b) engineering, systems and technology; and (c) management and social sciences.

E. Space transportation

38. The Russian Federation continued the use of the middle- and heavy-class launchers of the Soyuz, Molniya and Proton type to launch communication, scientific and many other payloads into different orbits (including GSO). Launchers Tsiklon and Zenit were produced in cooperation with Ukraine. The most used cosmodrome in the world - the cosmodrome at Plesetsk - was responsible for 60 per cent of Russian launchings and 10 per cent worldwide. During the 30 years of its existence (from March 1966), there had been almost 1,500 successful launchings. Plans were progressing for a possible gradual building of the new Russian cosmodrome at Svobodny (Amur region) in the eastern part of the country.

39. Converted military rockets Start-1 and the more powerful Start and Rokot used solid fuel and would also be used in the space programme. A Russian space corporation, a Ukrainian research and production centre Yuzhnoe, a United States company and a Norwegian shipbuilding company, were all cooperating within the framework of an international consortium on the preparation of commercial launchings from a sea-based platform near the equator.

40. The Association of Space Explorers (ASE) supported and endorsed the concept of the "X-Prize", a prize of US\$ 10 million that would promote private industry development of a reusable, single stage, sub-orbital vehicle capable of carrying three adults (300 kg) to an altitude of at least 100 kilometres above the Earth. The Association believed that the X-Prize would stimulate public interest in space exploration and development, and lead to the capability to fly many people into space, goals which the ASE promotes.

F. Astronomy and planetary exploration

41. In early 1995, the international astronomical community was dismayed by the publication of a proposal on behalf of the United Nations Educational, Scientific and Cultural Organization to mark its fiftieth anniversary by a launch of a solar reflector, the "Star of Tolerance". It was to have been in the form of a double star comprising two reflecting balloons (one of 50 metres, the other of 30 metres in diameter, both connected by a 2-kilometres tether). It would orbit the Earth at 1,250 kilometres and appear as bright as the star Sirius, or even as the planet Jupiter. Fortunately the project was abandoned. The "Star" itself would not be a disaster for astronomy, although it would be a significant hazard. What did cause major concern within the astronomical community was the precedent it would set, if implemented. It would be a clear signal that it was culturally, scientifically and educationally acceptable to use spaceborne solar reflectors to convey messages on an international scale.

42. In the field of radio astronomy, there were problems with artificial radio transmissions from orbiting satellites. The interference caused by the Global Orbiting Navigation Satellite System (GLONASS) at 1612 MHz had recently been resolved. Thus, the conditions for observing the important oxygen-hydrogen maser line at that frequency would rapidly improve. However, a newly proposed satellite communication system, Iridium, was again threatening radio astronomical use of that band. Although Iridium and the United States National Radio Astronomy Observatory had reached a memorandum of understanding, the remainder of the radio astronomical community, with good reason, regarded that bilateral agreement as a poor basis for the future. What was needed was some kind of operational mandate that would allow astronomy, civilization, industry and commerce to coexist.

43. Another mobile communication project, Teledesic, was looking for an allocation of frequency in the very high frequency range in the 19 to 29 GHz band, hitherto an unallocated millimetre wavelength. That spectral region was one of particular importance to radio astronomy since there were many interstellar line emissions. The detection of those signatures of the nature of cosmic chemistry would be of crucial importance in discerning how large chemical molecules could be constructed and where in the Universe such processes took place. Great care would have to be exercised in assigning the millimetre frequency range for communications, if access to such far-reaching astronomical information was to be maintained.

44. The International Conference on Near-Earth Objects was held in New York from 24 to 26 April 1995. It was co-sponsored by the Explorers Club, the Planetary Society and the United Nations. The subject of the conference, Near-Earth Objects (NEO), was based on comets and asteroids whose orbits could intersect the orbit of the Earth around the Sun. Since it has been generally understood that the impact of a kilometre-size NEO would have severe consequences on the terrestrial biosphere, it was of some interest to estimate its probability. Astronomy and planetary science had shown that craters were an ubiquitous, if not dominant, feature on planets, moons and asteroids within the inner solar system. Detailed studies of the cratering record indicated that the impact of NEO 1 kilometre or greater in size was a regular occurrence, with continuity over large time scales.

45. The main focus of NEO research at the present time should be towards generating more knowledge about the origin, evolution and dynamical and material characteristics of asteroids and comets that could interact within the immediate space environment of Earth. Heightened public awareness about NEO and hazards associated with possible impacts must be met with a responsible explanation based on scientific knowledge. From that perspective, NEO research provided an opportunity to pursue interdisciplinary scientific research in the basic space sciences through international cooperation.

Notes

¹Official Records of the General Assembly Fiftieth Session, Supplement No. 20 (A/50/20), para. 102.

*Annex**

**SCIENTIFIC AND TECHNICAL PRESENTATIONS TO THE SCIENTIFIC AND
TECHNICAL SUBCOMMITTEE AT ITS THIRTY-THIRD SESSION**

CONTENTS

	<i>Page</i>
I. SYMPOSIUM ON UTILIZATION OF MICRO- AND SMALL SATELLITES FOR THE EXPANSION OF LOW-COST SPACE ACTIVITIES	10
A. Use of Small Satellite Technology in Developing Countries	10
B. Example of Cooperative Microsatellite Projects	11
C. Small Satellite Projects in Latin America	13
D. Microsatellite Project of the Republic of Korea	14
E. Microsatellite Project of the Republic of South Africa	15
F. Small Satellite Projects in Spain	16
G. Small Satellite Projects in Central Europe	16
H. French Small Satellite Projects	18
I. Small Satellite Missions of ESA	18
J. Small Satellite Technology in the United States of America	19
II. OTHER SCIENTIFIC AND TECHNICAL PRESENTATIONS	20
A. Measurements of Space Debris	20
B. Modelling of the Space Debris Environment and Technical Assessment	22
C. The Use of Nuclear Power Sources in Outer Space	24
D. Remote Sensing Applications for Global Mapping and Environmental Monitoring	25
E. International Space University - Providing Education Programmes to Professionals	28
F. Space Transportation	28
G. Astronomy and Planetary Exploration	29
<i>Appendix.</i> List of scientific and technical presentations	32

*This annex has not been formally edited.

I. SYMPOSIUM ON UTILIZATION OF MICRO- AND SMALL SATELLITES FOR THE EXPANSION OF LOW-COST SPACE ACTIVITIES

A. Use of Small Satellite Technology in Developing Countries

In view of the growing interest in the subject of small satellites, the International Academy of Astronautics (IAA) established in 1993, the Subcommittee on Small Satellites for Developing Nations. The Subcommittee considers small satellites to be a driving force for developing countries to initiate a space programme, train their personnel and develop their research and technological infrastructures. In most developing nations, at least two categories of needs for small and micro-satellite systems can be identified. The first group may be classified as direct needs, and relates to social and economical problems which may be addressed through various applications of space technology. The second group may be classified as indirect needs and deals with attaining the condition of taking full advantage of a country's investments in acquisition of space systems and services.

Direct needs can be further classified by geographic location, types of services and products or types of applications. Although some developing nations present some developed areas where the needs are very similar to those of developed nations, today it is more significant to focus on problems such as communications and monitoring of remote areas, agricultural land use and environmental protection.

The use of Low Earth Orbit Communications (LEOCOM) systems allows many services. One of the most interesting is the communication between a portable terminal and a normal telephone connected to the existing fixed telecommunication network. In this case, the two users may be located anywhere in the territory and, in particular, in remote areas or regions lacking a communications infrastructure. Communication between two mobile users as well as between a mobile user and a user of the fixed network system anywhere around the globe is also possible.

The use of automatic Data Collection Platforms (DCP), in conjunction with the two-way characteristics of LEOCOM allows for the installation of a data collection network which features wide coverage and provides real-time service. In addition, the LEOCOM system can provide the location of any user of mobile terminals with an accuracy in the hundred meter range. The LEOCOM mobile terminal can also be coupled to a facsimile machine for the transmission of graphical data. In this regard, for instance, it allows a user to send a facsimile of an electrocardiogram in the case of a medical emergency in a remote area.

Telemedicine is an application which will increase efficiency of medical services by allowing the transmission of information obtained by inexpensive and simple sensors directly to complex processing units in large medical centres where it might be interpreted by specialized physicians. This makes it possible for powerful and effective emergency services to reach poor and undeveloped areas, saving many lives and avoiding unnecessary displacement of patients. The Healthsat project is a very good example of a telemedicine application using a 60 kg micro-satellite in low Earth orbit (LEO) to relay medical data information between Nigeria and North America. Mobile communications may also play an important role in the case of natural disasters, allowing for help to reach the disaster victims earlier and providing logistic support to rescue teams.

Many developing nations have had an early access to the benefits of satellite remote sensing, but still have a long way to go in order to maximize the benefits allowed by the existing capabilities. There are, however, unique needs at both national and regional levels that demand new solutions. Brazil and the Republic of Korea for instance, are already developing new satellite programmes to

address their specific needs. Developing countries in Latin America, South-East Asia and in other regions require special sensor parameters such as spectral bands, spatial resolution and time resolution. This in turn merits an examination of the cost of images, the level of investment in ground equipment, and the expertise required for utilization.

As a consequence of the relative lack of space science studies in the southern hemisphere, several natural phenomena that occur in the upper atmosphere in the tropical and southern hemisphere zones are not adequately understood. This concerns, for example, the ionospheric plasma depletions which occur over South America and strongly interfere with radio communications as well as the South Atlantic Anomaly which is well known for the occurrence of energetic particles stemming from the inner radiation belt and causing severe damage to, or even complete destruction of, satellite instrumentation. Therefore, it seems highly advisable that developing countries that are located in the southern hemisphere and, in particular, in the tropical zone, join the global effort towards improving the knowledge of their own space environment. Many such countries have been engaged in astrophysical studies (particularly of the sky regions which are not observable from the northern hemisphere) in the past few decades and small satellites would be an important means of complementing these ground-based studies.

Cooperative space activities are often supported by some kind of technology transfer. A successful technology transfer in the development of a small satellite project implies a process by which a team acquires sufficient momentum to be able to produce the next generation of small satellites. There are several mechanisms whereby technology transfer can be achieved, but to be successful, the transfer should be a transfer of understanding, not the transfer of a technology package (know-why as well as know-how). Examples of programmes where engineers from developing countries are trained on small satellite design, production and operations are numerous. The University of Surrey of the United Kingdom has, for example provided such assistance in the development of small satellites weighing less than 100 kg to Chile, Pakistan and the Republic of Korea, as well as to small countries in Europe that have decided to initiate a space programme.

There are several ways to obtain launch access for small satellites, either on a purely commercial basis or through participation in international cooperative agreements. A country may also consider developing its own launch capability. A driving force in pursuing this approach is the lack of available low cost launchers and an inability for the country to meet their launch requirements on a timely basis if the country views access to space as critical to their national development. Acquisition of launch services from international commercial sources is sometimes preferable to cooperative arrangements, due to difficulties in finding an appropriate exchange opportunity. In particular, countries seeking their first launch may find a commercial acquisition the most effective route open to them.

Cooperative missions may be considered when a clear programmatic benefit is shared by more than one country with a mutual desire to maximize their unique national resources and available funding. International cooperative agreements vary from mission to mission and country to country. Most require a particular country to assume full financial and technical responsibility for its portion of the cooperative effort. In general, in the event of such a division of labor, clean and distinct managerial and technical interfaces should be detailed in such agreements.

B. Example of Cooperative Microsatellite Projects

Microsatellites UoSAT 3 and 5, KITSAT 1 and 2 and PoSAT 1 provide examples of the use of a microsatellite platform for collaborative space science research between the University of Surrey (United Kingdom), the Korea Advanced Institute of Science and Technology (KAIST) and Portuguese

research institutions. A small payload monitors the near-Earth radiation environment and provides an important opportunity to validate ground-based numerical models with flight data yielding simultaneous measurements of the radiation environment and its effects upon on-board systems.

The University of Surrey has pioneered microsatellite technologies since beginning its UoSAT programme in 1979. The need to accommodate a variety of payload customers within a standard Ariane Structure for Auxiliary Payloads (ASAP) launcher envelope, coupled with increased demands on packing density, economy of manufacture and ease of integration, catalyzed the development of a novel modular design of a multi-mission platform. It is based around a series of standard module trays which house the electronic circuits and themselves form the mechanical structure onto which solar arrays are mounted. Electronically, the microsatellite uses modern, sophisticated (but not necessarily space-proven), electronic circuits to provide a high degree of capability. These are underpinned by space-proven subsystems resulting in a layered architecture that achieves redundancy by using alternative technologies rather than by simple duplication.

Communications and Earth observation payloads require an Earth-pointing platform. Therefore, the microsatellite is maintained to within two degrees of the center of the Earth line by employing a combination of gravity-gradient stabilization (using a six meter boom) and closed-loop active damping using electromagnets operated by the on-board computer. Attitude determination is provided by Sun, Earth horizon, star field, and geomagnetic field sensors, while orbital position is determined by an on-board Global Positioning System (GPS) receiver. Electrical power is generated by four body-mounted Germanium Arsenic (GaAs) solar array panels (each generating around 35W) and is stored in a 7Ah NiCd rechargeable battery. Communications are supported by VHF up links and UHF down links, capable of transferring several hundred kBytes of data to brief-case sized communications terminals.

Various constellations of small satellites in LEO have been proposed to provide world-wide communications using only hand-held portable terminals which broadly fall into two main categories: real-time voice and data services and non-real-time data transfer. The close proximity of the satellites in LEO to the user and the consequent reduction in transmission loss and delay time appear attractive when compared to traditional communications satellites in a distant geostationary orbit. This holds out the promise of less expensive ground terminals and regional frequency reuse. The communications characteristics associated with a LEO constellation pose however, quite different and demanding problems, such as varying communications path and links, high frequency shifts, and hand-over from satellite to satellite.

Microsatellites can offer quick turn-around and inexpensive means of exploring well-focused, small-scale scientific objectives (e.g. monitoring the space radiation environment, updating the international geomagnetic reference field, etc.) or providing early proof-of-concept prior to the development of large-scale instrumentation in a manner, fully complementary to expensive, long-gestation, large-scale space science missions. The UoSAT missions have demonstrated that it is possible to progress from concept through to launch and orbital operation within 12 months and a budget of \$4 million. This not only yields early scientific data, but also provides opportunities for young scientists and engineers to gain "real-life" experience of satellite and payload engineering and to be able to initiate a programme of research, propose and build an instrument, and retrieve space data for analysis and presentation for a thesis within a normal period of postgraduate study.

Conventional Earth observation and remote sensing satellite missions are extremely costly - typically over \$200 million each. The development of high-density two-dimensional semi-conductor charged coupled device (CCD) optical detectors, coupled with low-power consumption microprocessors, presents a new opportunity for remote sensing using inexpensive satellites. Clearly,

the limited mass, volume, stability and optics of microsattellites cannot compete with traditional large-scale missions such as Landsat, SPOT and ERS. However, for medium resolution and meteorological-scale imaging, the KITSAT and PoSAT satellites have demonstrated a comparable facility but at a tiny fraction of the cost. This is attractive for developing nations in particular that are interested in possessing an independent remote sensing facility under their direct control at a very modest cost, even if the resolution is limited.

The latest PoSAT 1 microsattellite carries two independent cameras providing a wide-field ground resolutions of 2 kilometers for meteorological imaging and a narrow-field ground resolution of 200 meters for environmental monitoring with 650 nanometers optical filters providing good separation of arid/vegetation and land/sea boundaries. The future mini-satellites of this series will support Earth imaging cameras yielding better than 100 meter resolution with three spectral bands.

Microsattellites also provide an attractive and low-cost means of demonstrating, verifying and evaluating new technologies or services in a realistic orbital environment and within acceptable risks prior to commitment to a full-scale, expensive mission. Examples of this opportunity include new solar cell technologies, modern Very Large Scale Integration (VLSI) devices in space radiation as well as demonstrations of advanced communications. Because satellites depend upon the performance of solar cell arrays for the production of primary power to support on-board housekeeping systems and payloads, knowledge of the long-term behavior of different types of cells in the radiation environment is essential. Unfortunately, ground-based, short-term radiation susceptibility testing does not necessarily yield accurate data and hence there is a real need for evaluation in an extended realistic orbital environment. This can be accomplished easily and cheaply on-board microsattellites.

Although microsattellites are physically very small, they are nevertheless complex and exhibit virtually all the characteristics of a large satellite. This makes them particularly suitable as a focus for the education and training of scientists and engineers by providing a means for direct, hands-on experience in all stages and aspects (both technical and managerial) of a real satellite mission - from design, construction, testing and launch to orbital operation. The very low cost, rapid time frame and manageable proportions makes this approach very attractive to countries wishing to develop and establish a national expertise in space technology. In this connection, according to the experience of the University of Surrey, collaborative education programmes typically have the following elements: academic education (MSc., PhD degrees), on-the-job training on a real microsattellite mission, cooperation on establishing and operating ground stations with participating countries, and finally the necessary technology transfer (design license).

C. Small Satellite Projects in Latin America

A small satellite project in Argentina, Scientific Application Satellite B (SAC-B), is being prepared in cooperation with the United States. The main purpose of the project is to design a satellite with a scientific payload to advance the study of solar physics and astrophysics. The mass of the satellite is about 180 kg with an expected active lifetime of a minimum of three years. It will have a circular orbit at 550 kilometers that has an inclination of 38 degrees. On-board experiments include an examination of energetic particles and radiation from solar flares, the localization of sources of intense transient emissions of gamma ray radiation, the monitoring of galactic and extragalactic X-Ray diffuse background and examination of energetic neutral atoms in radiation belts (in cooperation with Italy). The launching of this satellite is scheduled for 1996. A new generation of satellites designed for scientific research and remote sensing, SAC-C and SAC-D, is being prepared for launch in 1999 through 2006.

In Brazil, great significance is attached to the collection of data from remote platforms using space technology. The Brazilian Complete Space Mission (MECB) successfully started in February 1993 by the launch of the *Satelite de Coleta de Dados* (SCD 1) satellite. It is a small 105 kg spinning satellite for collection and distribution of environmental data acquired by data collecting platforms distributed over Brazilian territory, mainly in the Amazona region. The satellite has remained operational for two years after its expected useful life (1 year). At least two similar satellites will be launched to ensure continuity of the mission. In addition, the improved SCD 3 satellite (200 kg) would have the mission of proving the concept of voice and data communications in the equatorial region.

The Equatorial Communicator (ECO-8) study is funded mainly by the Brazilian government. A system of 8 satellites in equatorial orbit at 2,000 kilometers altitude can provide constant coverage of regions up to 30 degrees on both sides of the equator. It is intended for voice communications between mobile terminals or between a mobile and a fixed terminal. It can also provide a real-time, uninterrupted dissemination of data collected by automatic platforms located anywhere in this equatorial belt. ECO-8 would require no communication links between satellites and allow for at least 200 simultaneous connections. The Equatorial Constellation Communication Organization (ECCO) is planned for the implementation and operation of wide area personal communications (including cellular-quality voice, data and fax) to rural and remote areas in the equatorial region. The ECCO system, scheduled to begin full operation in the first quarter of 1998, will consist of 12 satellites (including one spare). It will reach over 100 countries in Latin America, South Asia, Africa and the Middle East. This would mean that more than 35 percent of the total land mass and more than 40 percent of the world's population would be covered by this system.

The first Brazilian microsatellite for scientific application, SACI-1, should be launched in October 1997 as a piggyback to the China-Brazil Earth Resources satellite (CBERS). The payload of SACI-1 is composed of four scientific experiments - measurement of Earth air glow emissions, measurement of the anomalous cosmic radiation fluxes, investigation of plasma bubbles and investigation of the geomagnetic field effect on charged particles. The ground segment should consist of two receiving stations in Brazil and users ground data collecting stations. A cost effective LAN PC-based tracking and control system will be implemented and scientific data as well as payload on-board configuration will be distributed through the Internet in order to decentralize and facilitate the interfacing between the payload and its customers.

In Chile, the first operational satellite will be FASat-Bravo, developed in cooperation with the University of Surrey. This 46 kg microsatellite would be put into circular orbit at 650 kilometers with an inclination of 82.5 degrees in August 1996. It will carry ozone layer monitoring experiment, a data transfer experiment, an experimental Earth imaging system and other equipment, including an educational experiment. Using the communications link provided by the satellite, students will be able to engage in study activities (orbital mechanics, satellite communications analysis, telemetry analysis etc.) one or two days per month. In fact, a similar microsatellite, FASat-Alpha, was launched into orbit as a piggyback to the Sich-1 satellite on-board a Tsiklon booster on 31 August 1995. The object separated normally from the booster, but the microsatellite failed to separate from Sich. The problem with the pyrotechnic device is now being studied to assure its proper functioning next time.

D. Microsatellite Project of the Republic of Korea

The Satellite Research Center of the Korea Advanced Institute of Science and Technology (KAIST) began its programme to develop space technology with the launch of two scientific and experimental microsatellites KITSAT 1 and 2 in 1992/93. An agreement worth \$4.6 million was signed in 1990 by KAIST with the University of Surrey, covering training, two microsatellites and a ground

station. Students took the university MSc courses in Satellite Communications and Spacecraft Engineering. The second microsatellite was built in Korea, using the experience gained during the preparation of the first microsatellite in the United Kingdom. Through this first step into space, the KAIST has trained many engineers and scientists and successfully acquired microsatellite systems technologies.

Currently, KAIST is involved in designing its new indigenous satellite KITSAT 3 to enhance the capabilities of the previous two microsatellites. A primary objective of this programme is to develop a microsatellite system which has highly accurate attitude control and high speed data transmission. It shall also provide hands-on experience to Korean space industries and research institutes. KITSAT 3 will carry a remote sensing multispectral pushbroom CCD camera and several space science experiments. The remote sensing payload will be able to monitor environmental disasters such as floods, volcanic eruption and earthquake damage in the Asia-Pacific Region. The space science experiments should measure the distribution of highly energetic particles in Earth radiation belts and geomagnetic field intensity around the mission orbit and also monitor the total dose of radiation encountered by the solid state memory device.

The total mass of the KITSAT 3 microsatellite will be less than 100 kg and the dimensions of the main box-like body are approximately 45 cm by 45 cm by 60 cm. The satellite consists of a sensor platform, a payload platform, a reaction control unit, a bus platform and a battery with adaptor. The GaAs solar cells are expected to generate more than 100 watts when fully illuminated and not to be degraded by more than 30 percent after three years of mission life. There are three solar panels; two of which are deployable (unlike the first two microsatellites), while the third is fixed on the main body. The attitude control system uses reaction wheels and enhanced magnetorques to achieve full 3-axis stabilization.

The KITSAT 3 is expected to be launched into heliosynchronous polar orbit with an altitude of about 800 km in the middle of 1997. An engineering model will be completely manufactured and tested by the end of April 1996. It also includes a qualification test for the launcher which should also be selected this year. Future planned missions in Korea include the development of the advanced small satellite KITSAT 4, based on KITSAT 3 architecture. This small satellite of a 300 kg should include a new 5 meter resolution linear CCD camera system and a demonstration of a hybrid propulsion system.

E. Microsatellite Project of the Republic of South Africa

In South Africa, the SUNSAT microsatellite project was started in 1992 to increase engineering design opportunities for graduate students and to increase industrial and international interaction with the Stellenbosch University. The microsatellite has the mass of 60 kg and is basically box-shaped with dimensions 45 cm by 45 cm by 60 cm and should provide satellite images of cultivated fields, natural vegetation and pollution around the globe. It shall also include an electronic mailbox orbiting Earth to receive and deliver messages; speech and data relay experiments to schools; a unique method of training graduate students; and research in satellite engineering. SUNSAT should be launched by a United States Delta launcher in March 1997 into polar orbit at 450 to 850 kilometers (originally, heliosynchronous circular orbit had been envisioned), together with the Danish magnetospheric research satellite Oersted. SUNSAT will also carry the GPS navigational receiver of the National Aeronautic and Space Administration (NASA) of the United States, and a set of laser reflectors for precise positioning experiments.

The SUNSAT microsatellite was developed by about 28 graduate students who designed and built most of the electronics and about half of the mechanics, with the assistance of technical personnel of the Engineering Faculty (technical drawings, printed circuit board layout and manufacturing of the body structure). Solar panels are located on all four sides of the satellite and can deliver 140 watts of power to rechargeable NiCd batteries. Attitude determination is made by horizon, Sun and star sensors as well as by a magnetometer. Orientation control is provided by reaction wheels, magnetorquers and a gravity gradient boom. A high resolution camera can image the Earth in three colours and stereo. Its spatial resolution is 20 meters from 800 kilometers altitude.

F. Small Satellite Projects in Spain

Spain was one of the first countries to develop its own satellite. On 15 November 1974, a United States Delta launcher put into orbit, the INTASAT satellite weighing about 25 kg with a 45 cm diameter, corresponding to what is now called a microsatellite system. This technological satellite measured space radiation and, using its solar batteries, functioned in a 1450 km orbit for a full two years. Unfortunately, there was no immediate continuation of this successful project and Spain got involved in larger scale projects (communications satellites of the HISPASAT series and participation in ESA projects). It was only on 7 July 1995 that a second Spanish microsatellite UPM-Sat 1 was launched by an Ariane 4 rocket into a 650 kilometer circular heliosynchronous orbit. It was developed at the Universidad Politécnica in Madrid and has a mass of 47 kg.

UPM-Sat continues experiments started twenty years ago by INTASAT and its development has strengthened cooperation between academic and industrial entities in the country. There are plans for the launching of satellite UPM-Sat 2 (nicknamed MATIAS, for Mediciones Atmosféricas, Telecomunicaciones, Ingeniería y Aplicaciones de los Satélites) in 1998. The main purpose of this satellite is to investigate atmospheric pollution and provide for data collection and transmission. Another project, Vehicle for Education of the Network of Universities in Space (VENUS) is currently being negotiated with several interested universities in Europe and Latin America. It could be realized under the UPM-Sat 3 series of satellites.

Another Spanish space project, MINISAT, was entrusted to Instituto Nacional de Técnica Aeroespacial (INTA), by the Spanish Inter-ministerial Commission for Science and Technology (CICYT) in 1992. Modular satellites of 180 to 500 kg mass (depending on the number of modules used) would be launched by Pegasus airborne launchers starting in 1996. The first satellite MINISAT 01 will consist of the basic platform and will be used for scientific research (monitoring of the diffusion of extreme ultraviolet radiation in the atmosphere, detection of low-energetic gamma radiation and materials science). Satellite MINISAT 1 will be an upgraded version, equipped for remote sensing observations. MINISAT 2 will use the basic platform to provide long-distance communications even from the geostationary orbit. In addition, INTA has been recently involved in the programme NanoSat, aimed at the development of a 20 kg microsatellite for communication with the Spain's scientific base Juan Carlos I in Antarctica. The project was initiated in 1995 and targeted for satellite launch in 1998.

G. Small Satellite Projects in Central Europe

A small scientific sub-satellite MAGION 4 was launched on 3 August 1995 together with the INTERBALL 1 "mother" satellite. MAGION 4 separated from the mother satellite after reaching the planned orbit (apogee 191,907 kilometers, perigee 793 kilometers, inclination 63.0 degrees). The satellite has a mass of 60 kg and was developed by the Institute of Atmospheric Physics (Czech Republic), the Technical University Graz (Austria) and the Space Research Institute (Russian

Federation). Its scientific payload is aimed at the study of geomagnetic field, wave phenomena and plasma parameters of the ionosphere in frame of the INTERBALL space project. Simultaneous measurements from two satellites, which move along practically the same orbit at a relatively small distance from each other, allow for temporal and spatial resolution of the observed phenomena.

During the initial period of about two months after launch, the spatial orientation of the orbit enabled study of the magnetopause and bow-shock regions, while from October 1995 to January 1996, the satellite orbit was in the region of geomagnetic tail. On 9 January 1996, the distance between the two spacecraft reached 43.5 minutes along the orbit (MAGION 4 crossed "the same" region of space 43.5 minutes earlier). The MAGION 4 on-board thruster (using pressurized gas designated also for reorientation of the spin axis to the Sun) changed the orbit several times in January-February 1996, so that both satellites should again be close together in May 1996. The ability to control the separation distance is important for the study of fine structures of the magnetopause, bow-shock and solar wind plasma. Similar twin satellites should be launched into the geomagnetic polar region as part of the INTERBALL project in July 1996.

The Central European Satellite for Advanced Research (CESAR) is a spacecraft of about 300 kg that will fly in orbit with a 400 kilometers perigee, 1000 kilometers apogee and 70 degree inclination. The scientific mission is related to the study of the magnetosphere, ionosphere and thermosphere (MIT) environment. Ten different experiments, provided by scientists from Austria, Czech Republic, Hungary, Poland and Slovakia will be accommodated on-board the spacecraft which is funded by the Italian Space Agency, ASI, and designed by Alenia Spazio. This mission is one of the objectives of the cooperation among the countries of the Central European Initiative (CEI).

A feasibility study for CESAR has been started and a detailed technical study funded by ASI will be conducted by Alenia Spazio concerning the spacecraft's system engineering. The participating countries will develop the experiments they are responsible for and will collaborate with each other regarding on-board accommodations for the experiments.

The nominal mission lifetime will be two years which will allow a sufficient period of observation of the complex MIT phenomena. The evolution of the initial orbit will be determined by natural perturbations since no propulsion capability is provided on-board. The once-per-orbit perigee-apogee excursion, combined with the slow procession of the orbital plane with respect to the Sun and the Earth, will provide the payload with complete sampling of the near-Earth environment between 400 and 1000 kilometers and ± 70 degrees latitude in all conditions of illumination over the lifetime of the mission.

The spacecraft should be launched by direct injection into its required orbit by a small launcher (either an improved Scout or Pegasus). Deployment of the solar array and S-band antennas will follow separation. The spacecraft will be attitude stabilized by spinning around a sun-pointing axis with a rate of 4 rpm. The spin rate will provide the experiments with a fast scan and sampling of the environment surrounding the spacecraft. Boom mounted experiments will be deployed after attitude acquisition. About one month of spacecraft commissioning and experiment calibration will follow. After the nominal operation of the satellite has been certified, the science mission will be carried out for the following two years.

The present configuration foresees a mass budget of about 151 kg of service module and 95 kg of payload module for an operative launch configuration mass of 246 kg. A mass margin of 20 percent is accounted for in the next phase of the project to take into account increases that will surface during the development process. The spacecraft is expected to be completed before the end of 1997

for a launch at the beginning of 1998. CESAR will be the first spacecraft of a series that will also include a second spacecraft currently in preparation, the Joint Ultra Violet Night Sky Observer (JUNO), a UV astronomy satellite being developed in cooperation with NASA. A definition phase study for JUNO is underway.

H. French Small Satellite Projects

A working group on small satellites was created by the Centre National d'Études Spatiales, France (CNES) at the end of 1993 to propose recommendations for the development of a series of small satellites complementing the SPOT system, at a cost of less than 300 million French francs per mission and development time of two years. The recommended programme, *Plateforme Reconfigurable pour l'Observation, les Télécommunications et les Usages Scientifiques (PROTEUS)* is a satellite that should have a mass less than 500 kg (including 250 kg of useful payload), available power of 100 to 300 watts and pointing accuracy of 0.1 to 3 degrees. Technological studies were performed during 1994/95, ending by the selection of industrial partners. The first flight is envisioned in 1999 as a continuation of the successful France - United States altimetric satellite project *Topex-Poséidon*. Possible orbits are at 500 to 1400 kilometers and satellite should be able to maneuver and change its orbit with a total velocity change of 60 to 180 m/s.

Possible scientific missions using the PROTEUS platform include astronomy (project SAMBA for registration of local fluctuations of 3K background radiation from the Big Bang and COROT for astero-seismology), space environment (IBIZA for registration of the plasma accelerated in the geomagnetic aurora regions), Earth sciences (TPFO, Vagsat, Irsute, Tropiques), and fundamental physics (QUICK-STEP for verification of the equivalence of inertial and gravitational mass). From applications missions, priority is given to radio communications and optical observations. In parallel with the PROTEUS platform, CNES is making studies of a microsatellite with less than 100 kg of mass. It would be used mainly as a test platform for new technological concepts.

I. Small Satellite Missions of ESA

The missions which are being considered by the Small Missions Opportunities (SMO) initiative of the European Space Agency (ESA) may be classified by the following parameters: 150 to 500 kg launch mass, orbit between 600 and 900 km, development time of about two years, cost of less than 40 million ECU for platform and integration, delivery on orbit, commissioning and user ground station. This is a class of small missions which is generating a lot of interest, and where the European industry is not yet as competitive as it is in the microsatellite field. In this regard, European industry, through its trade association Eurospace, came to ESA with the suggestion that ESA should pool together a sufficient number of missions, from ESA's own programs and from those planned by Member States. Various ESA Member States have flown, are developing or are planning small missions. With few exceptions, these missions have involved or will involve development of a single spacecraft. When more spacecraft are to be realized, this will happen at 3 to 4 year intervals.

The basic idea of the SMO initiative is to have a common procurement of part or all of the following mission elements: launch, platform integration and ground segment. This approach should achieve low cost benefits for recurrent elements of a mission, while preserving the user's control over the mission payload and operations. The possibility of efficiently integrating a number of different missions on a common subset of equipment has already been demonstrated by various small satellite programs, such as NASA's Small Explorers. Actual contents of the SMO initiative will be defined after an analysis of proposed mission requirements, which will be performed in the second phase of on-going studies. At present, the launch opportunity seems to be the strongest common denominator.

If the SMO initiative is successful, Europe will have an SMO Operator, able to deliver a scientific or commercial payload in orbit at low cost. Because this initiative addresses a user community with different levels of capability (some Member States have an autonomous SMO capability, some do not), the SMO Operator will be ideally suited to fulfill the different needs of emerging countries. Participation in the SMO initiative could take at least two forms: via another international organization, with a mission dedicated to emerging countries, or via agreement with a participating ESA Member State. Assuming a Member State decides this year to support the SMO initiative, a program could start as early as 1997 and the first launch would take place towards the end of 1999.

J. Small Satellite Technology in the United States of America

In addition to the support (technological assistance, launching arrangements) provided to emerging space-faring nations, as described in other parts of this report, NASA has adopted its own Small Spacecraft Technology Initiative (SSTI). This technology programme should reduce the cost and development time of space missions for science and commercial applications. It should achieve a payload/total mass fraction of up to 70 percent. Time from development to flight readiness should be two years. To achieve those goals, new design and qualification methods for small spacecraft should be demonstrated using commercial and performance-based specifications, integration of small instrumentation technology into the satellite bus design and end-to-end product development and flight verification. The future NASA mission capability should result in 30 to 60 percent reduction of costs and new technology insertion into missions.

The first two satellites, named Lewis and Clark, will carry more than 30 different technology demonstrations. Lewis will fly three instruments, including a "hyper-spectral imager" having 384 spectral bands (the operational LANDSAT satellite only has seven bands). It is designed to enhance traditional remote sensing applications in agriculture, global environmental monitoring, forestry, land management and industrial planning. Clark will carry four scientific payloads combining a very high 3 m resolution optical imager with stereo-imaging capabilities. This will be used for commercial remote sensing, disaster management and urban planning. The satellites will have a mass of 272 and 317 kg respectively, from which about 70 percent accounts for the scientific payloads (in existing satellites, it is typically 40 percent). The launch vehicle will most likely be the Pegasus-XL. The Integrated Product Development team, which will manage the project, consists of more than 35 members from the manufacturing company, NASA centers, universities and high schools.

One of the innovative, yet not well publicized projects, is the GPS Gravity field modeling. The first satellite to carry a precise GPS receiver was Topex/Poseidon oceanographic satellite. Its data had been combined in a new model of the Earth gravity field which illustrated the power of this method. To improve this model, the GPS atmospheric occultation project needs many transmitters and receivers aloft at once, densely sampling the global atmosphere every few hours. The preliminary proposal is for twelve satellites launched at once into a single orbit plane by 1998. Until the arrival of GPS and low cost microsats, the evident cost of such an enterprise made it impractical within Earth science programmes. Space borne GPS imaging will have a profound impact on ionospheric science. The ability to image ionospheric structures continuously in three dimensions will help scientists to examine in detail the evolution of "space weather", to trace the formation of geomagnetic storms, and perhaps one day to predict when an observed solar flare will cause disruption on Earth.

NASA is also preparing a series of small, low-cost planetary science missions under its Discovery programme. They are designed to provide frequent investigative opportunities (one launch every 12 to 18 months) to the planetary research community while encouraging partnerships with industry. All

solar system targets and objectives are valid candidates for the Discovery programme, but the spacecraft cost should be low and the launch vehicle will be limited to Delta class or smaller. A total of 28 proposals had been received in response to the first announcement of opportunity, covering the full range of planetary science objectives (next announcement of opportunity is to be released in May 1996). The first four missions are now fully funded, and their development is on schedule and within cost guidelines.

The first of the Discovery missions, called NEAR (Near Earth Asteroid Rendezvous) was launched on 17 February 1996 towards an encounter with asteroid 433 Eros. The initial close pass at Eros will occur on 6 February 1999 at a distance of about 500 kilometers. The spacecraft should be then maneuvered even closer to the asteroid (below 25 kilometers) and orbit it for about one year, making precious measurements of its characteristics. Mars Pathfinder is the second Discovery mission planned for launch on 2 December 1996, and should land on Mars on 4 July 1997. It should investigate the structure of the Martian atmosphere, monitor surface meteorology, observe surface geology and measure elemental composition of the rocks and soil. The third small planetary mission, Lunar Prospector, will be launched in June 1997. Its science objectives include a global mapping of surface chemistry, search for the presence of ice near lunar poles, detailed investigation of magnetic and gravity fields at high resolution and identification of possible gas release events. A comet-sample return mission (launch in February 1999) will be the fourth Discovery flight during which Stardust will rendezvous with comet Wild-2 in January 2004. It should return to Earth the first samples of comet material in January 2006.

II. OTHER SCIENTIFIC AND TECHNICAL PRESENTATIONS

A. Measurements of Space Debris

The largest radar tracking facility in western Europe is at FGAN (Research Establishment for Applied Science) at Wachtberg-Werthhoven (Germany). FGAN operates an L-band tracking and Ku-band imaging radar using a 34 meter parabolic dish antenna. Data from this site are an important addition to the catalogue of data in the case of re-entry predictions for high-risk space debris. ESA has sponsored research of the feasibility of detecting and tracking medium-size debris (1 to 50 centimeters) with L-band radar. Metal spheres of 5 centimeter diameter are measured frequently and one meter objects are detectable in the geostationary orbit (GSO) using a multi-pulse signal processing techniques. A one day beam park (fixed antenna position) experiment has been carried out jointly with the Fylingdales station (United Kingdom). Hardware and software upgrades are being implemented to enhance the detection performance of the existing Tracking and Imaging Radar (TIRA) for medium-size debris in Low Earth Orbit (LEO). A further beam park experiment is planned in the bi-static mode with the radiotelescope at Effelsberg. The measurements will be used to validate and improve current environmental models.

Regarding the debris measurement by optical telescopes, ESA will use a one-meter Zeiss telescope which is currently being installed at the Teide Observatory on Tenerife (Canary Islands, 28.3 degrees north latitude) for other purposes. The configuration of this Ritchey-Chrétien-Coudé system has been extensively analyzed with respect to possible changes and upgrades to enable space debris observation and tracking. The optical system dedicated to space debris measurement will cover the spectral range from visible to near infrared and will have a field of view of 0.6 degrees. As a detector, a nitrogen cooled CCD camera with a mosaic of four 2048x2048 chips is under consideration. Special methods and computer algorithms are required to extract from CCD data the orbital parameters and other characteristics of space objects. The minimum size of detectable objects will be 2 to 6

centimeters in LEO and 20 to 40 centimeters in GSO. The telescope should be operational for space object observations at the beginning of 1997.

Objects moving in near-Earth space are regularly tracked and catalogued by the United States Space Command (USSC) Space Surveillance System. This system operates more than two dozen radar and several optical facilities to monitor near-Earth space. It also maintains a catalogue of orbital elements of all tracked objects. The minimum diameter of observable objects is about 10 centimeter for LEO and 1 meter for GSO. Objects in GSO are tracked mainly by the dedicated optical system GEODSS (Geosynchronous and Deep Space Surveillance). Currently, orbits are maintained for over 8,000 objects and the USSC Catalogue is the main source of essential information for detecting breakups and monitoring growth of the debris environment. Current surveillance systems have difficulties in cataloguing some space objects in highly elliptical orbits (HEO) and low-inclination orbits. Objects in HEO are more difficult to detect because they spend a large fraction of their time at very high altitudes, and objects in low-inclination orbits because of the relative lack of sensors at low latitudes.

In addition, a special radar located at Haystack (near Boston, Massachusetts) is capable of detecting objects less than 1 centimeter in diameter in LEO and obtain statistical information on number, flux, size and altitude (but not complete orbital information). There seems to be over 100,000 pieces of space debris in LEO at sizes down to 1 centimeter. The Haystack data suggest that there may be major sources of centimeter-sized orbital debris other than previously recorded breakups. The large number of objects in orbits between 900 and 1,000 kilometers with orbital inclinations between 60 and 70 degrees have relatively smooth and spherical shapes (according to the polarization data), rather than the irregular shapes that would typically be created in a breakup. This combination of orbital and physical characteristics suggests that these objects may be tens of thousands of 0.6 to 2.0 centimeter liquid droplets of a sodium/potassium coolant leaking from the nonfunctional cores of Russian nuclear power sources (NPS) satellites. Also NASA's deep space tracking radar at Goldstone (California) confirms the existence of this type of debris. This radar, capable of detecting 2 millimeter objects at 600 kilometers is only available for space debris measurements for a few hours per year.

A dedicated optical Schmidt telescope with a main mirror of 32 centimeter aperture, located at Haleakala site (Maui, Hawaii) is able to detect 60 centimeter objects in the GSO. During 252 total hours of observation from 1992 to 1994, it revealed that about 30 percent of objects detected by its CCD sensor appeared to be debris. In the future, much larger liquid surface mirror telescope will be used for observation of GSO objects. Recent new technology enables construction of the 3 meter diameter rotating mercury mirror, equipped with a hypersensitive CCD detector and with full computer control.

Information on particles smaller than about 1 millimeter is obtained mostly through special detectors carried by spacecraft or through the analysis of impacts on material that has been exposed to the space environment. For the first time, an impact detector will be placed on a geostationary spacecraft. A spare dust detector of Galileo/Ulysses probes, developed by the Max-Planck Institute for Nuclear Physics at Heidelberg (Germany), will be flown this year on the Russian EXPRESS 2 spacecraft. In the framework of the EUROMIR 95 project, dust and debris impact experiments are carried out outside the MIR space station. On the external platform European Science Exposure Facility (ESEF), a number of experimental cassettes have been installed. The cassettes have been retrieved during the extra-vehicular activity of the cosmonauts on 8 February 1996 and returned to Earth on 29 February 1996.

Many European researchers have analyzed impact features on NASA's Long Duration Exposure Facility (LDEF) after its retrieval in January 1990, following 69 months in orbit at altitudes between 340 and 470 kilometers. Of the more than 30,000 LDEF craters visible by naked eye, 5,000 have diameters larger than 0.5 millimeter. The largest crater (5 millimeters) was probably caused by a 1 millimeter particle. In general, it is difficult to determine the composition of an impacting particle and therefore to distinguish between impacts of micrometeoroids and artificial space debris. The European Retrievable Carrier (EURECA) spacecraft, launched in July 1992 was retrieved by the space shuttle after 326 days in orbit at a mean altitude near 500 kilometers. The spacecraft has since then undergone extensive post-flight analysis with regard to impact features. It revealed 71 impact sites on the thermal blankets, and 14 impacts on the body plates, including the largest impact feature with 2 millimeter crater diameter. Also EURECA's solar arrays of 96 square meters total surface area were scanned by different European research groups. More than 1,000 impacts were detected on the front side of each of the two wings, while only about 44 were noticeable on the rear sides. From a total of 847 of the larger impact sites, high resolution microphotographs were taken. The largest impact crater diameter is 6.4 millimeters, resulting from an object of 0.5 to 1 millimeter diameter. Further analysis will concentrate on impactor characterization (e.g. mass, direction, velocity, chemical composition) and on hypervelocity calibration experiments conducted with the spare solar array surface material.

A similar analysis programme is also ongoing for the solar array retrieved from the Hubble Space Telescope (HST) in December 1993, after 3.62 years in an orbit of about 600 kilometers mean altitude. Due to the high operating altitude and extended dwell time, a larger number of impacts is observed on its total surface area of 62 square meters. The largest hole diameter is 2 to 3 millimeters.. As the flexible HST blankets have a total thickness of 710 microns, several impacts (2 to 4 per square meter) have completely penetrated the material. On the other hand, it appears that the HST array did not suffer any functional damage from the many impacts. The European Space Technology Centre, Netherlands (ESTEC) is currently developing a database to archive images and analysis results of impact features on the EURECA and HST surfaces. Results of these analyses will be used to validate the present reference flux models for small size meteoroids and space debris.

Examination of windows, radiator panels and other surfaces of the United States Space Shuttle orbiters show that environmental models underestimate the microdebris population and that this population is growing with time. While the NASA space debris damage model Bumper predicted 13 window replacements in 12 shuttle missions, the actual number of replacements was 19. The source of actual window damage (i.e. meteoroid or debris) was determined by scanning electron microscope analysis and compared to Bumper predictions. While micrometeoroid damage was predicted correctly (10 actual over 11 predicted), microdebris damage is underestimated more than three times (8 actual over 2 predicted).

B. Modelling of the Space Debris Environment and Technical Assessment

Models of the space debris population are needed to fill in gaps in existing measurement data, to interpret new data, and to project the characteristics of the future debris environment. There are two major classes of debris models in use today. Population characterization models take information about the orbital elements and other characteristics of space objects and convert them into measurable parameters such as flux, detection rate for an instrument, or collision velocity. More complex models are used to understand the future growth in the debris population. These model types are not entirely distinct; the output of a model of one type is often used as the input for a model of the other type.

A comparison of different space debris models with observations have been performed by a special working group of CNES. It is a first step of a three-step programme. The second step is an

accurate risk analysis for space missions followed by the third step, proposals for space debris mitigation procedures. For "small" debris (below 10 centimeters), mathematical models should give the flux of particles for calibration with observations on-board spacecraft. For a more detailed comparison with observations, current detectors are not sufficient and a new generation of detectors is therefore proposed. The main reference model considered by CNES for space debris population is that of D. J. Kessler (NASA, Johnson Spaceflight Center, Houston, Texas) and for micrometeoroids, the model of E. Grün (Max-Planck Institute, Germany). The main inputs are the size of particles, altitude, inclination and date. Main outputs of these models are: the flux in orbit (number of impacts per square meter per year), consisting of micrometeoroids flux, debris flux and total flux. The total number of impacts also depends of course on the duration of the mission and the effective area of the spacecraft involved.

For comparison with models, the following data have been used: from the FRECOPA experiment (5.7 years in orbit) on the LDEF satellite, from the ARAGATZ mission (1 year in orbit) on the Mir space station, from the analysis of solar panels (11 months in orbit) of the EURECA platform and from the solar panel (3.6 years in orbit) of the HST observatory. The method of analysis consists of localization of the impacts, identification of the particle nature (debris or micrometeoroids), and conversion from the diameter of the crater to the size of the particle. Finally, the number of impacts as a function of particle diameter and histogram of frequencies (number of impacts per diameter class) led to the estimation of the cumulative flux which can be compared with model prediction.

In general, good accordance between model predictions and measurements has been found. There are some discrepancies for small particles of 10 to 100 micrometer in size as well as a slight underestimate of the model for the Mir station orbit. To improve the data sources, a new generation of detectors is prepared with low mass and energy consumption, but enabling estimation of instantaneous (not only cumulative) flux. The on-board recording of the time of impacts is also important for estimation of debris environment evolution as a function of time. Mock-ups of the new detectors are now tested in hypervelocity chamber and in a short time, new detectors should be available for use in different orbits (on Mir and SPOT 4 spacecraft).

Unique debris hazards associated with the proposed satellite constellations have been studied by the United Kingdom. A satellite constellation is a distributed architecture of satellites to provide global positioning, Earth observation, hand-held personal communications, messaging or data transfer. There are proposals for a large number of new systems, which means that over 1000 new satellites will be placed into high inclination orbits at altitudes between 700 and 800 kilometers and 1200 to 1400 kilometers within 4 to 6 years. Among the most advanced projects, the communication satellite constellation Iridium should consist of 77 satellites, Teledesic of 924, Globalstar of 48, Orbcomm of 26, etc. Realization of such projects will result in concentrations of satellite mass at certain regions of space around Earth.

To keep the constellation operational, frequent satellite replacement launches are envisioned. During the launch and deployment phase, there are usual problems associated with the explosion of launch vehicles or explosion and collision with fragments from un-passivated upper stage or with some non-tracked object. In addition, there is a possibility of collision with other satellites being deployed. At the operational orbit, additional hazards include collisions with uncontrolled constellation satellites, fragments from constellation satellite breakups or from launch vehicle breakups. Also de-orbiting of non-operational satellites should be planned so as to avoid collision with other satellites in the constellation.

The probability of collisions with debris within the constellation was modelled using different assumptions on the number of orbital planes and frequency of catastrophic collision breakups and explosion-induced breakups. It was found that there is a low probability of short-term collision cascading effect, but a high probability of cascades with background debris population. A careful selection of operational practices will be needed to guarantee long-term functioning of the proposed satellite constellations.

To acquire an unbiased technical assessment of the research needed to better understand the debris environment, the necessity and means of protecting spacecraft against the debris environment, and potential methods of reducing the debris hazard, NASA asked the National Research Council to form an international committee to examine the orbital debris issue. The committee was asked to draw upon available data and analyses to: (i) characterize the current debris environment; (ii) project how this environment might change in the absence of new measures to alleviate debris proliferation; (iii) examine on-going alleviation activities; (iv) explore measures to address the problem; and (v) develop recommendations on technical methods to address the problems of debris proliferation.

In the summer of 1993, the National Research Council formed a committee of eleven technical experts from six spacefaring nations to perform this task. In 1995, a report "Orbital Debris - A Technical Assessment" was published, representing the consensus view of the committee. The committee strove to ensure that the study focused on technical issues. This report does not suggest appropriate funding levels for future debris research, nor propose specific protective measures for particular spacecraft, nor lay out detailed implementation strategies for techniques to contain the future debris hazard. Decisions on such matters involve political and economic as well as technical considerations and must be made by entities capable of weighing all these factors. Rather, this report seeks to provide engineers, scientists, and policy makers with the sound technical information and advice upon which such decisions must be based.

C. The Use of Nuclear Power Sources in Outer Space

A numerical analysis related to possible collisions of NPS with space debris has been performed by the Russian Federation. The following contingencies have been examined in particular: destruction of the NPS structure, change of orbital parameters of NPS after collision, its entry into the atmosphere, and possible atmospheric destruction and fallout of radioactive toxic material particles and parts of the NPS structure. Collisions with space debris have been considered for reactors launched in the period 1970 - 1988 and injected into orbits within the 700 to 1000 altitude range. A typical reactor has a mass of 1250 kg, a diameter of 1.3 meters and a length of 5.7 meters incorporating fuel rod assembly and radiation shield. A fuel-element assembly of 53 kg contains 37 fuel rods, each with steel cladding, fuel pin of uranium-molybdenum alloy and axial reflectors of beryllium.

Collisions with space debris capable of considerable or catastrophic (e.g. 10 percent of mass) NPS damage down to small fragments and particles or creation of such velocity impulse that could lead to substantial change of orbital parameters and untimely re-entry from initial orbit were considered. For typical NPS orbits (altitude 930 to 970 kilometers, inclination of 65 degrees), the most probable relative velocity of collision is about 12 kilometers per second at an angle of collision of 108 degrees. Estimated probabilities of collision with space debris larger than 0.5 centimeters were computed for 250 years into the future using model distribution of debris as of 1994 and corresponding to the present rate of spacecraft launchings. The probability of collision is sufficiently high and reaches 1 in 55 years. For space debris more than 2 centimeters in diameter (capable of considerable NPS destruction), the collision probability should be lower and is subject to further computations.

Research on aerodynamic destruction of NPS and the fuel rod assembly during their descent into the atmosphere after collision at the initial re-entry trajectory (altitude 160 kilometers) has confirmed, that the NPS structure destructs in a range of altitude between 74 and 64 kilometers, the reactor and fuel rod assembly between 64 and 50 kilometers and reactor fuel pins (uranium - molybdenum alloy) down to particle dimensions of less than 1 millimeter in the range between 50 and 47 kilometers. Only partial destruction of the beryllium axial reflectors (melting of the external layer) occurs.

The fallout of millimeter size nuclear fuel particles, allowing for uranium fission product decay at the moment of collision, will not lead to a significant change in the radiation levels over the fall-out territory. The fall of beryllium reflector parts and partially failed radiation shield of lithium hydride may constitute a threat from the point of view of toxicity, which will prompt search and clean-up (removal) measures. The set of measures on the prediction of NPS re-entry orbital parameters, region of re-entry into dense layers of the atmosphere, territory of the fall-out of radioactive particles and NPS structure parts were developed by the Russian Federation earlier. They may be used in the event of detection of the collision between NPS and space debris. Similarly, inspection and control of radiation situation procedures on the fall-out territory, search, location and removal of fallen parts were applied in connection with NPS reactor launchings.

In the United Kingdom, studies continued on possible supplements to the Principles relevant to the use of nuclear power sources in outer space, adopted by the General Assembly on 14 December 1992. While this Resolution includes valuable consensus agreements on topics such as consultation, assistance to States affected by an accident, liability and compensation it suffers from a number of limitations. Among these are the exclusion of propulsion and extra-terrestrial bases; their formulation in terms of particular technologies; ignoring the potential effects of space debris; and inconsistencies with the more mature safety principles developed for the terrestrial applications of nuclear power. Therefore, a revision is suggested which generalizes the intentions embodied in Resolution 47/68 in a way which is consistent with subsequent international developments under the aegis of the International Commission on Radiological Protection (ICRP) and IAEA. The revision takes the form of six Supplementary Principles incorporating developments in probabilistic risk assessment, safety culture and radiological protection together with the recognition of the importance of safeguards. Subject to a consensus being reached on these Supplementary Principles and their associated numerical risk values (A/AC.105/C.1/L.203), this opens the way to eliminating the need for exceptions so that the revised principles are of universal applicability.

D. Remote Sensing Applications for Global Mapping and Environmental Monitoring

With the successful design, development, launch and in-orbit performance of the first generation of the Indian remote sensing satellite IRS, India is surging ahead to provide improved and enhanced data services from the second generation of remote sensing satellites, IRS-1C and 1D. IRS-1C, launched on 6 December 1995, is characterized by an improved spatial resolution, extended spectral bands, stereo viewing and faster re-visit capability. Besides cartographic applications, the IRS-1C mission mainly addresses the following areas:

- Crops and vegetation applications with specific reference to mixed crops and vegetation discrimination;
- Oceanographic applications, in particular observations of physical oceanographic parameters such as winds, sea surface temperature, waves, etc., and biological parameters;

- Atmospheric applications for monitoring global changes such as the depletion of the ozone layer over the Antarctic region.

The major elements of the IRS-1C mission, besides the spacecraft itself, are the Space Craft Control Centre, the Payload Data Reception Stations and the Data Products Generation Centre. IRS-1C operates in a circular, heliosynchronous, near polar orbit with an inclination of 98.69 degrees, at an altitude of 817 km in the descending node. IRS-1C needs approximately 100 minutes to orbit Earth, which means that the satellite completes 14 orbits each day. The entire surface of Earth is covered after 341 orbits during a 24 days cycle.

IRS-1C carries three imaging sensors which are characterized by enhanced resolution. The Panchromatic camera (PAN) has a spatial resolution of 5.8 meters, operates in the spectral range of 0.5 to 0.75 micrometers and employs three CCD devices of 4096 elements each. A multispectral Linear Imaging Self-Scanner (LISS-3) camera provides images with a spatial resolution of 23 m. This camera is also capable of producing images in the near infrared band (1.55 - 1.70 micrometers wave length). The Two-Band-Wide Field-Sensor (WiFS) operates in the visible and near-infrared region with a swath width of 810 km and resolution 190 meters.

Space research activities in Morocco, related to remote sensing and environmental monitoring, are characterized by an active, realistic and long-term policy at both the national level (coordination, information, training and project formulation) and the international level (participation in forums, international committees and bilateral and multilateral projects). The use of outer space in Morocco is becoming ever more developed, extensive and diversified.

With regard to satellite data, stations are currently in operation to receive METEOSAT weather satellite data, such as the National Department of Meteorology (DMN) station. There are plans to set up two NOAA stations, one for meteorological studies at the DMN and the other at the Royal Centre for Spaceborne Remote Sensing (CRTS) for receiving advanced very high resolution radiometer (AVHRR) data. This station is to be set up within the framework of the GLOVE project, which is co-financed by the European Union.

In the fields of data exchange and remote sensing networks, CRTS is coordinating Moroccan efforts to set up the Cooperation Information Network (COPINE) project launched by the United Nations Office for Outer Space Affairs. This project aims to establish satellite communication stations (INTELSAT) in a number of African countries enabling them to exchange data with each other and with European countries, particularly in the areas of the environment, natural resources and tele-medicine. The opening up of rural areas is a facet of the project of particular interest to national users.

A number of projects combining spaceborne remote sensing and geographic information systems (GIS) are in the process of development or implementation. These projects are designed to meet needs in the areas of natural resource inventory and management, environmental protection and town and country planning within the context of national and regional development programmes.

In the area of on-going training, CRTS has continued organizing short (one-week) and longer (two-week) courses to provide an introduction into the basic principles of spaceborne remote sensing, geographic information systems, and applications in areas of particular interest to the Kingdom of Morocco and the region. These courses, especially those relating to water resources, desertification, common grazing land and the management of fishery resources, are regularly attended by African participants in positions of responsibility.

GEOSPACE, a company located in Austria, is currently conducting a global mapping project to produce a digital atlas of the world. This global satellite image mapping project aims at developing a global geographic information system, which is easy to use, cost-effective and easily accessible for frequent updates. Studies are performed at the local, regional and international level.

The global mapping project, in particular has arisen due to recent regional and global environmental and economic changes, such as increasing pollution of land and water, dramatic population growth and changing consumption patterns. Such a project would be an essential contribution to sustainable development and the preservation of the environment. The project shall also play a vital role in the overall process of homogenizing spaceborne data, which would tremendously facilitate the timely provision of satellite derived information on the environment and natural resources.

The main benefits to be obtained through the global mapping project will be the availability of a cost-effective high resolution global geographic information system. Funding for the project shall be provided by national, regional and international organizations, and it is hoped that both the governmental and the private sector will contribute to the project.

The status of new commercial remote sensing satellites was reviewed by the Secretary General of ISPRS. These new satellites are intended to provide high resolution (up to 2 to 5 meters) data in the areas of meteorology, cartography, natural resources and commercial imaging. Countries who in the recent past have been involved in the development of such commercial remote sensing satellites are France, Germany, India, Japan, the Russian Federation and the United States. Furthermore, the European Space Agency plays a major role in the development of new remote sensing satellites.

An outlook for the next decade indicates that 99 Earth observation satellite payloads are planned to be implemented, out of which 57 payloads should be established within the next five years. These new payloads will play a significant role in developments towards digital photogrammetry and remote sensing.

Photogrammetry and remote sensing are the key ingredients in the spatial information sciences for monitoring Earth's environment, assessing and predicting natural disasters, thematic mapping, preservation of national and international security and sustainable development. In the near future, spacefaring nations will develop remote sensing satellites with spatial resolutions in the range of 1 meter.

In the context of accelerating economic and environmental development, a programme entitled "Resource 21" will be launched in the near future. Resource 21 is an information service company with the objective to improve agriculture, environment and natural resource monitoring. It is a market driven programme and combines satellite remote sensing, telecommunications and information systems technology. Resource 21 shall provide information products within hours of satellite data acquisition. It will also provide coverage of Earth every three days with a spatial resolution of 10 m. The system will be comprised of four satellites with a swath width of 205 km. Resource 21 should be operational in 1999.

A further system to be implemented in the near future is the geophysical and environmental Earth resource observation system (GEROS), aiming to provide timely and accurate information on agriculture, forestry and coastal zones. This system will be comprised of six satellites, the first of which is scheduled to be launched in 1998.

E. International Space University - Providing Education Programmes to Professionals

The International Space University (ISU), established in 1988, places emphasis on an interdisciplinary, international and intercultural space education programme. ISU is dedicated to the education and development of professionals in all disciplines (such as creators, innovators, managers and leaders) in space-related fields, the creation and expansion of knowledge through research, and the exchange and dissemination of knowledge and ideas. All of the above activities contribute to the development of space-related activities for peaceful purposes, the improvement of life on Earth and the education and inspiration of leaders and innovators who will guide humanity beyond the next frontier.

During the course of the summer session programmes of ISU, comprehensive lectures are provided in all space-related disciplines as well as discussions on how these disciplines can interact. Furthermore, an international space project is designed during the summer curriculum, resulting in a professional report with practical utility for the international space community. Overall, these summer curricula strengthen the development of professional skills and personal qualities required to design, implement, lead and manage major phases of space programmes.

The ISU summer session provides an intensive 10-week programme hosted at a different location each year. To date, nearly 1,000 students have participated in summer session programmes. In addition, 450 internationally recognized space experts (astronauts and cosmonauts, designers and engineers, space medical doctors, scientists, physicists, historians, policy makers, lawyers, managers, entrepreneurs, etc.) from 25 countries have contributed as lecturers since 1988.

During the summer curriculum, a series of core lectures are held, providing an introduction to basic concepts of the following disciplines: System Architecture & Mission Design; Business & Management; Engineering; Life Sciences; Policy & Law; Resources, Robotics & Manufacturing; Satellite Applications; Physical Sciences; Space & Society and Informatics. Following the core lectures, a series of themes and specialized lectures intends to deepen the knowledge in specific areas, containing contemporary and future issues.

In addition to the summer session programmes, ISU has recently launched a "Master of Space Studies" Programme, held at its Central Campus in Strasbourg, France. This one-year graduate level programme comprises three major elements: (a) Sciences and Applications, (b) Engineering, Systems and Technology, and (c) Management and Social Sciences.

F. Space Transportation

The Russian Federation continues the use of middle and heavy class launchers of the Soyuz, Molniya and Proton type to launch communication, scientific and many other payloads into different orbits (including GSO). In addition to the Russian national space transportation programme, these launchers are also used in furtherance of international cooperation. The Tsiklon and Zenit launchers are produced in cooperation with Ukraine. The most used cosmodrome in the world - Pleseck - is responsible for 60 percent of Russian launchings and for 10 percent worldwide. During the thirty years of its existence (since March 1966), there were almost 1,500 successful launchings. Plans are progressing for a possible gradual building of the new Russian cosmodrome at Svobodny (Amur region) in the eastern part of the country.

To prolong the exploitation cycle and improve ecological parameters, a small modernization of launchers is to be made by the year 2000. The modified Proton-M launcher has the capacity to carry

21,700 kg to LEO instead of the current 20,600 kg capacity. It will have an advanced guidance system, more powerful first stage engine as well as improved ecological parameters. Tests of the modified, ecologically clean version of the Soyuz launcher should start soon at the Pleseck cosmodrome under the name Rus. It will have new engines at all three stages and an improved guidance system. In addition, development of the perspective, ecologically clean two-stage launcher Angara is continuing. It is made up solely of Russian components and will be also launched from the Pleseck cosmodrome. It can deliver 25 metric tons of payload into a 200 kilometer LEO with 63 degrees inclination. All fluid components - oxygen, kerosene and hydrogen are non-toxic.

Converted military rockets Start-1 and the more powerful Start use solid fuel and will also be used in the space programme. Another converted military launcher, Rokot, can be launched from its underground silo. It will be used for launching of smaller payloads into low and middle orbits for purposes of the Russian national space programme and also for international cooperation efforts. The integrated operation system also includes a launching complex (based on the complex used for Kosmos launchers), a service complex (based on Tsiklon serving) and tracking and telemetry, transport etc.

The Russian space corporation Energiya, the Ukrainian research and production centre Yuzhnoe, the Boeing corporation of the United States and a Norwegian shipbuilding company, are cooperating in the form of an international consortium named Sea Launch on the preparation of commercial launchings from a sea-based platform near the equator.

Another project of interest is the aircraft-launched booster Burlak. It is a two-stage liquid fuel rocket that can deliver 500 kg payload into LEO. A detailed proposal is also being worked out for the Aerokosmos two-stage rocket that separates from the aircraft on a parachute. Other ideas being developed in this area include the light two-stage launchers, Kvant and Ricksha, the latter aiming to deliver about 5 metric ton of payload into LEO.

The Association of Space Explorers (ASE) presented the concept of the "X-Prize" - a prize of \$10 million designed to promote private industry development of a reusable, single stage, sub-orbital vehicle capable of carrying three adults (300 kg) to an altitude of at least 100 kilometers above Earth. ASE believes that the X-Prize will stimulate public interest in space exploration and development, and lead to the capability to fly many people into space, a goal which ASE actively promotes. The spacecraft must be privately financed and privately built. It must be flown twice within a 14-day period. Each flight must carry at least one adult to a 100 kilometer minimum altitude, but it must be built with the capacity to carry a minimum of three adults. The second flight must demonstrate a low per-flight cost and vehicle reusability. Both crew and spaceship must return to Earth, "substantially unharmed", from both trips. Entrants must specify their take-off and landing location prior to the flight. The spacecraft must make a controlled landing within five kilometers of the chosen landing site. The X-Prize is international and open to anyone who abides by the rules.

G. Astronomy and Planetary Exploration

In early 1995, the international astronomical community was dismayed by the publication of a proposal on behalf of UNESCO, to mark its 50th anniversary by the launch of a solar reflector - the "Star of Tolerance". It was to have been in the form of a double star comprised of two reflecting balloons, one of 50 meters and the other of 30 meters in diameter connected by a 2 kilometer tether. The Star would transmit radio messages and, with the right receivers, be able to activate additional ground based events such as switching on floodlighting of buildings, etc. It would appear as bright as the star Sirius, or even as the planet Jupiter, orbit the Earth every two hours at a height of 1250 kilometers. Its visibility would be confined to the twilight sky. It was suggested that after four years

in orbit, the "Star" would have its orbit lowered in order to re-enter the atmosphere. The "Star" itself would not be a disaster for astronomy, even though it would be a significant hazard. What did cause major concern within the astronomical community was the precedent it would set, if implemented. It would be a clear signal, that it was culturally, scientifically and educationally acceptable to use spaceborne solar reflectors to convey messages on an international scale.

But development may not stop with solar reflectors - they are of limited usefulness for advertising because their brightness is limited by the efficiency of reflecting sunlight. The existence of such a fundamental limit, diluted by the inverse square law, reflection inefficiency and atmospheric extinction, seems to be recognized already. In 1994, SKY TV announced that it was considering space projection of its logo as a hologram produced by spaceborne lasers. In this situation, there is no limitation of visibility close to twilight and the energy expended is only bounded by engineering and financial constraints. Were such schemes demonstrably feasible (SKY TV based its suggestion on a NASA authority that stated that it was possible), then multiple space holograms would ensure not just the demise of deep sky astronomical imaging, but the whole of astronomical observation at optical wavelengths.

In the field of radio astronomy, there are problems with artificial radio transmissions from orbiting satellites. The interference caused by the GLONASS (Global Navigation Satellite System) at 1612 MHz has been resolved recently. Thus the conditions for observing the important OH maser line at that frequency should rapidly improve. However, the newly proposed satellite communication system Iridium is again threatening radio astronomical use of that band. The down link frequency from the satellites at 1620 MHz will be adjacent to the reserved radio astronomy band at 1610.6 to 1613.8 MHz. Since commercial transmissions must use higher power and astronomy is endeavouring to detect a weak cosmic signal, the possible spill of artificial transmission could mimic emissions from radio galaxies. Although Iridium and the United States National Radio Astronomy Observatory have reached a Memorandum of Understanding, the remainder of the radio astronomical community, with good reason, regards that bilateral agreement as a very poor basis for the future. What is needed is some kind of operational mandate which would allow astronomy, civilization, industry and commerce to coexist.

Another mobile communication project, Teledesic, is looking for an allocation of frequency in the hitherto non-allocated millimeter wavelength, very high frequency range in the 19 to 29 GHz band. This spectral region is one of peculiar importance to radio astronomy since there are many interstellar line emissions. It is subject to absorption (mostly by water vapour) so that there are only a limited number of transparent windows at these frequencies. Satellite up and down links must use these windows for commercial exploitation, and radio astronomy needs them to detect the faint interstellar spectrum lines emitted by a wide range of molecular species. Such studies contribute to understanding the structure and evolution of our own and other galaxies, formation of stars and planetary systems and, possibly, the development of life. The detection of these signatures of the nature of cosmic chemistry will be of crucial importance in discerning how large chemical molecules can be constructed and where in the Universe such processes take place. Very great care will have to be exercised in assigning the millimeter frequency range for communications if access to such far reaching astronomical information is to be maintained.

In addition, mobile multi-satellite systems, like Iridium, Teledesic and others, are demanding very large numbers of satellites in LEO. These satellites will reflect sunlight and exacerbate the worsening space debris problem. A study of the United Kingdom Schmidt Archive at the Royal Observatory Edinburgh has shown that satellite trailings on precious astronomic plates has increased from 1.5 trails per hour of exposure in 1978 to 2.5 in 1994. More deep sky imaging and photometry will be degraded

as a consequence when such projects become operational. Clearly, systematic thought is urgently needed to minimize the impact on both radio and optical astronomy. Attention should be given to restoration of astronomic observing conditions to a state where the hazards are as close to natural limitations as may yet be practicable. Above all, no activity of itself should be permitted which would terminate unilaterally major techniques for obtaining astronomical information and data.

The International Conference on Near-Earth Objects was held in New York on 24 to 26 April 1995. It was co-sponsored by the Explorers Club, the Planetary Society and the United Nations. The subject of the conference, Near-Earth Objects (NEO), was comets and asteroids whose orbits could intersect the orbit of the Earth around the Sun. The possibility of collision between the Earth and NEO has been the subject of much speculation regarding the likelihood and consequences of such an event. Since it has been generally understood that the impact of a kilometer size NEO would have severe consequences on the terrestrial biosphere, it is of some interest to estimate its probability. Astronomy and planetary science have shown that craters are an ubiquitous, if not dominant, feature on planets, moons and asteroids within the inner solar system. Detailed studies of cratering records indicate that the impact of a kilometer or greater sized NEO was a regular occurrence, with continuity over large times scales. The fossil records appear to suggest that our own progression from mammalian ancestors was assisted by a NEO impact that eliminated a vast number of species, including, at the cretaceous tertiary boundary (K/T), the predator dinosaurs.

The main focus of NEO research at this time should be towards generating more knowledge about the origin, evolution, and dynamical and material characteristics of asteroids and comets that can interact within Earth's immediate space environment. The heightened public awareness about NEO and hazards associated with possible impacts must be met with a responsible explanation based on scientific knowledge. From this perspective, NEO research is an opportunity to pursue interdisciplinary scientific research in the basic space sciences through international cooperation. Of prime operational importance is the creation and maintenance of an internationally organized NEO catalog and ephemeris (predictions) computation service. To this end, improved observational data are needed from both northern and southern hemispheres, especially for NEO under one kilometer diameter.

To underscore the importance of these observations and the uncertainty in determining a value, albeit approximate, for the probability of collision with the Earth, an analysis of the Earth crossing asteroid (Apollo, Amok, and Athens families) and comet (Jupiter and Halley families) statistics was carried out. It is suggested that the overall collision probability may be uncertain by a factor as large as five. This is primarily due to the relatively large number of smaller objects (below 200 meters) and the fact that only a very small percentage of this population has been discovered. To determine this population more accurately, observations must be extended to higher magnitude ranges and spectral classes wherever possible.

Obtaining an accurate number for the comet population does not appear to be so straightforward, since a determination of the ratio of passive to active comets proved to be extremely difficult. Therefore, further NEO studies should center around extensive and detailed observational work, from which modelling and other assessments could follow. Until this empirically based research is carried out, it will not be possible to realistically characterize the NEO threat, nor will the likelihood of a successful outcome from NEO countermeasures be assured in any way.

Appendix

LIST OF SCIENTIFIC AND TECHNICAL PRESENTATIONS

I. SYMPOSIUM ON UTILIZATION OF MICRO- AND SMALL SATELLITES FOR THE EXPANSION OF LOW-COST SPACE ACTIVITIES, TAKING INTO PARTICULAR ACCOUNT THE SPECIAL NEEDS OF DEVELOPING COUNTRIES, ORGANIZED BY COSPAR AND IAF

The first session of the symposium, entitled "Small satellite activities", was co-chaired by Mr. K. Doetsch, representing IAF, and Mr. W. Riedler, representing COSPAR. The second session of the symposium, entitled "The potential of micro- and small satellites", was co-chaired by Mr. J. Ortner, representing IAF, and Mr. K. Szegő, representing COSPAR. Mr. S. Grahn of COSPAR was the Rapporteur for both sessions of the symposium.

"Small Satellite Programmes in Developing Countries (Keynote Address)," Mr. P. Molette, Chairman of the Subcommittee on Small Satellites for Developing Nations, International Academy of Astronautics (IAA).

"The European Space Agency's Small Missions Opportunities (SMO) Initiative," Mr. F. Ongaro, Strategy Office, European Space Agency.

"Small Satellite Projects in Latin America," Mr. C. Puebla Menne, Comité de Asuntos Espaciales de Chile, Chile.

"An Introduction to KITSAT Program," Mr. S. Kim, Deputy Project Manager, Satellite Technology Research Center, Korea Advanced Institute of Science and Technology, Republic of Korea.

"Small Satellite Projects in Spain," Mr. A. Giménez, Director General, Instituto Nacional de Técnica Aeroespacial (INTA), Spain.

"Contribution of Small and Micro-Satellites to Scientific Research (Keynote Address)," Mr. K. R. Sridharamurthy, Indian Space Research Organization (ISRO), India.

"French Experience and Prospects in the Use of Small and Micro-Satellites for Space Science and Applications," Mr. P. L. Contreras, System Division Head, Toulouse Space Center, Centre National d'Etudes Spatiales (CNES), France.

"NASA Cooperation with Developing Nations on Small Satellite Programs," Mr. J. Mansfield, Associate Administrator, Office of Space Access and Technology, National Aeronautics and Space Administration (NASA), United States.

"Brazilian Small Satellite Program and its Particularities on Space Needs," Mr. D. Ceballos, Instituto Nacional de Pesquisas Espaciais (INPE), Brazil.

"The Sunset Project," Mr. S. Mostert, University of Stellenbosch, Republic of South Africa.

"Summary of the Symposium," Mr. S. Grahn, COSPAR.

II. OTHER SCIENTIFIC AND TECHNICAL PRESENTATIONS

"Space Debris Related Research at the Research Establishment for Applied Sciences (FGAN)," Mr. D. Mehrholz, FGAN, Bonn, Germany.

"Measurements of the Orbital Debris Environment," Mr. A. Potter, National Aeronautics and Space Administration (NASA), United States.

"Modelization of Space Debris and Comparison with Observations, Mr. F. Alby, Centre National d'Etudes Spatiales (CNES), Toulouse, France.

"Space Debris Research in ESA," Mr. W. Flury, ESOC, European Space Agency.

"Summary of the United States National Research Council Report on Orbital Debris: A Technical Assessment," Mr. G. Levin, National Aeronautics and Space Administration (NASA), United States.

"The Unique Debris Hazards Associated with Satellite Constellations," Mr. R. Crowther, Defence Research Agency, Farnborough, United Kingdom.

"Collision of Nuclear Power Sources with Space Debris," Mr. V. S. Nikolaev, Ministry of Atomic Energy of the Russian Federation.

"Interpretation and Development of the Safety Principles for Nuclear Power Sources in Space," Mr. B. Wade, AEA Technology, United Kingdom.

"Russian Space Transportation System," Mr. A. V. Yakovenko, Ministry of Foreign Affairs, Russian Federation.

"X-Prize: Development of a Reusable, Single-stage, Sub-orbital Vehicle," Mr. D. Prunariu, cosmonaut, Association of Space Explorers (ASE).

"ISU Design Projects on Small Satellite for Earth Observation for Polar Regions," Ms. L. Stojak, International Space University (ISU).

"Application Potential of Indian Remote Sensing satellite (IRS-1C)," Mr. R. R. Navalgund, Space Applications Centre, Ahmedabad, India.

"Applications of Remote Sensing in Cartography and Mapping," Mr. M. Saoud, Responsable technique (CRTS), Morocco.

"Status of New Commercial Remote Sensing Satellites: High Resolution Imaging Systems," Mr. L. W. Fritz, International Society for Photogrammetry and Remote Sensing (ISPRS).

"Geospace Global Mapping Project and the Digital Atlas of the World," Mr. L. Beckel, Geospace, Austria.

"Central European Satellite for Advanced Research (CESAR)," Mr. Z. Klos, Polish Academy of Sciences, Warsaw, Poland.

"Cooperation on Small Satellites," Mr. Y. B. Zoubarev, State Scientific Research Institute of Radio, Russian Federation.

"Solar Reflectors, Radio Astronomy and Access to the Sky," Mr. D. McNally, International Astronomical Union (IAU).

"Report on the International Conference on Near-Earth Objects," Mr. J. Remo, Organizer.



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COMMITTEE ON THE PEACEFUL
USES OF OUTER SPACE

**REPORT OF THE LEGAL SUBCOMMITTEE ON THE WORK OF ITS
THIRTY-FIFTH SESSION (18-28 MARCH 1996)**

CONTENTS

	<i>Paragraphs</i>	<i>Page</i>
INTRODUCTION	1 - 19	3
I. QUESTION OF REVIEW AND POSSIBLE REVISION OF THE PRINCIPLES RELEVANT TO THE USE OF NUCLEAR POWER SOURCES IN OUTER SPACE (AGENDA ITEM 3)	20 - 26	7
II. MATTERS RELATING TO THE DEFINITION AND DELIMITATION OF OUTER SPACE AND TO THE CHARACTER AND UTILIZATION OF THE GEOSTATIONARY ORBIT, INCLUDING CONSIDERATION OF WAYS AND MEANS TO ENSURE THE RATIONAL AND EQUITABLE USE OF THE GEOSTATIONARY ORBIT WITHOUT PREJUDICE TO THE ROLE OF THE INTERNATIONAL TELECOMMUNICATION UNION (AGENDA ITEM 4)	27 - 35	8
III. CONSIDERATION OF THE LEGAL ASPECTS RELATED TO THE APPLICATION OF THE PRINCIPLE THAT THE EXPLORATION AND UTILIZATION OF OUTER SPACE SHOULD BE CARRIED OUT FOR THE BENEFIT AND IN THE INTERESTS OF ALL STATES, TAKING INTO PARTICULAR ACCOUNT THE NEEDS OF DEVELOPING COUNTRIES (AGENDA ITEM 5)	36 - 42	9
IV. OTHER MATTERS (AGENDA ITEM 6)	43 - 52	10
V. INFORMAL CONSULTATIONS ON NEW ITEMS FOR THE AGENDA	53 - 57	11

Annexes

I.	Report of the Chairman of the Working Group on agenda item 4 (matters relating to the definition and delimitation of outer space and to the character and utilization of the geostationary orbit, including consideration of ways and means to ensure the rational and equitable use of the geostationary orbit without prejudice to the role of the International Telecommunication Union)	13
II.	Report of the Chairman of the Working Group on agenda item 5 (consideration of the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interests of all States, taking into particular account the needs of developing countries)	19
III.	Documents annexed to the report	28
A.	Matters relating to the definition and delimitation of outer space and to the character and utilization of the geostationary orbit, including consideration of ways and means to ensure the rational and equitable use of the geostationary orbit without prejudice to the role of the International Telecommunication Union	28
	Working paper: Colombia (A/AC.105/C.2/L.200 and Corr.1 of 15 March 1996)	28
B.	Consideration of the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interests of all States, taking into particular account the needs of developing countries	32
	Working paper: Germany and France (A/AC.105/C.2/L.197/Rev.1 of 19 March 1996)	32
C.	Consideration of the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interests of all States, taking into particular account the needs of developing countries	34
	Working paper: Brazil, Chile, Colombia, Cuba, Egypt, Iraq, Mexico, Nigeria, Pakistan, Philippines, Uruguay and Venezuela (A/AC.105/C.2/L.182/Rev.3 of 22 March 1996)	34
D.	Consideration of the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interests of all States, taking into particular account the needs of developing countries	36
	Working paper submitted by the Chairman of the Working Group (A/AC.105/C.2/L.202 of 27 March 1996)	36
E.	Informal consultations on new items for the agenda — unofficial background note by the Czech Republic, "Review of existing norms of international law applicable to space debris"	38
F.	Informal consultations on new items for the agenda — unofficial background note by Chile, "Comparison of the norms of space law and those of international environmental law"	39
G.	Informal consultations on new items for the agenda — unofficial background note by Mexico, "Review of the status of the five international legal instruments on outer space"	40

INTRODUCTION

Opening of the session

1. The Legal Subcommittee held its thirty-fifth session at the United Nations Office at Vienna from 18 to 28 March 1996 under the chairmanship of Mr. Václav Mikulka (Czech Republic).
2. At its opening, 589th meeting, the Chairman made a statement briefly describing the work to be undertaken by the Subcommittee at its current session. A summary of the Chairman's statement is contained in document A/AC.105/C.2/SR.589.

Adoption of the agenda

3. At the opening meeting, the Subcommittee adopted the following agenda:
 1. Opening of the session.
 2. Statement by the Chairman.
 3. Question of review and possible revision of the Principles Relevant to the Use of Nuclear Power Sources in Outer Space.
 4. Matters relating to the definition and delimitation of outer space and to the character and utilization of the geostationary orbit, including consideration of ways and means to ensure the rational and equitable use of the geostationary orbit without prejudice to the role of the International Telecommunication Union.
 5. Consideration of the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interests of all States, taking into particular account the needs of developing countries.
 6. Other matters.

Attendance

4. Representatives of the following States members of the Subcommittee attended the session: Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, China, Colombia, Cuba, Czech Republic, Ecuador, Egypt, France, Germany, India, Indonesia, Iran (Islamic Republic of), Iraq, Italy, Japan, Kazakstan, Lebanon, Mexico, Morocco, Nigeria, Pakistan, Philippines, Poland, Republic of Korea, Romania, Russian Federation, South Africa, Spain, Sudan, Sweden, Turkey, Ukraine, United Kingdom of Great Britain and Northern Ireland, United States of America, Uruguay, Venezuela and Viet Nam.
5. Representatives of the following specialized agencies and international organizations attended the session: International Telecommunication Union (ITU), International Atomic Energy Agency (IAEA), European Space Agency (ESA) and International Astronautical Federation (IAF).
6. The Chairman informed the Subcommittee at its 589th and 590th meetings that requests to participate in meetings of the Subcommittee had been received from Malaysia, Saudi Arabia, Slovakia, Thailand and the League of Arab States. The Subcommittee agreed that, since the granting of observer status was the

prerogative of the Committee on the Peaceful Uses of Outer Space, the Subcommittee could take no formal decision on the matter, but that the representatives of Malaysia, Saudi Arabia, Slovakia, Thailand and the League of Arab States might attend the formal meetings of the Subcommittee and could direct requests for the floor to the Chairman, should they wish to make statements.

7. A list of representatives of States members of the Subcommittee, States not members of the Subcommittee, specialized agencies and other organizations attending the session, and of the secretariat of the Subcommittee, is contained in document A/AC.105/C.2/INF.28.

Organization of work

8. In accordance with decisions taken at its opening meeting, the Subcommittee organized its work as follows:

(a) The Subcommittee recalled its recommendation, endorsed by the Committee on the Peaceful Uses of Outer Space,¹ that the yearly rotation of the order of consideration of substantive agenda items 3, 4 and 5 on a permanent basis (as recommended by the Committee)² should be suspended at the present session of the Subcommittee and that it should consider the three substantive items on its agenda (see paragraph 3 above) in the same order as in 1995: items 4, 5 and 3. However, acting in a flexible manner and in order to organize its work in an optimum way, the Subcommittee agreed to consider those items in the following order: items 4, 3 and 5;

(b) In accordance with the recommendation endorsed by the Committee on the Peaceful Uses of Outer Space,³ the Subcommittee agreed to suspend, for the present session, its Working Group on agenda item 3;

(c) It re-established its Working Group on agenda item 4, open to all members of the Subcommittee, and agreed that Mr. Eugenio Curia, the representative of Argentina, should serve as its Chairman;

(d) It re-established its Working Group on agenda item 5, open to all members of the Subcommittee, and agreed that Mr. Raimundo González, the representative of Chile, should serve as its Chairman;

(e) In accordance with the agreement reached by the Subcommittee at its thirty-fourth session, in 1995 (A/AC.105/607 and Corr.1, para. 54), the Chairman conducted open-ended, informal consultations with all members of the Subcommittee with a view to identifying, on the basis of consensus, a subject or a list of subjects that might be considered, in the future, for inclusion in the agenda of the Subcommittee;

(f) It began its work each day with a plenary meeting to hear delegations wishing to address the Subcommittee, and then adjourned and reconvened, when appropriate, as a working group, or began its work as a working group.

9. The following delegations participated in the general exchange of views: Austria, Brazil, China, Cuba, Ecuador, Germany, India, Indonesia, Italy, Japan, Morocco, Nigeria, Romania, Russian Federation, Turkey, Ukraine, United Kingdom of Great Britain and Northern Ireland, and United States of America, as well as ITU and IAF. The views expressed by those delegations are summarized in documents A/AC.105/C.2/SR.589-592.

10. The Working Group on agenda item 4 held seven meetings. The Working Group on agenda item 5 held five meetings.

11. The chairmen of the working groups reported to the Subcommittee at its 597th meeting, on 28 March (see annexes I and II to the present report). The Subcommittee took note with appreciation of the reports and of the work done in the working groups.

12. At the opening meeting, the Chairman made a statement concerning the utilization of conference services by the Subcommittee. He drew attention to the importance that the General Assembly and the Committee on Conferences attached to the effective utilization of conference services by all United Nations deliberative bodies. In view of that, the Chairman proposed, and the Subcommittee agreed, that the following measures, similar to those adopted in the past, should also be adopted at the current session of the Subcommittee:

(a) The Subcommittee and its working groups should begin their meetings punctually at the scheduled time, even if there was no quorum (16 members);

(b) The Office of Conference Services should be notified as early as possible whenever it was anticipated that any of the services usually provided were not going to be required. If possible, prior notice of 24 hours should be given;

(c) Informal consultations (i.e. outside the auspices of the Subcommittee and its working groups) should not interrupt the work of the Subcommittee or its working groups;

(d) The general rule for annexing documents to the report of the Subcommittee should be that normally any document would be annexed, if at all, only once, to the report of the session in which it was first submitted, but not to later reports;

(e) The Subcommittee should not have plenary meetings in the afternoons when the agenda items on definition of outer space/geostationary orbit and on outer space benefits were considered. Instead, the working groups on those items should meet;

(f) Delegations wishing to speak at the next plenary meeting of the Subcommittee should inform the Chairman of their intention before the adjournment of the previous plenary meeting. If no such information was received by the Chairman, the next plenary meeting of the Subcommittee should be cancelled and a working group should meet instead;

(g) The Subcommittee and/or working group meetings could be cancelled on an ad hoc basis if informal consultations were required, instead of planned cancellations of blocks of meetings, which had been employed in the past;

(h) There should be the possibility of holding informal meetings and consultations outside the work schedule of the Subcommittee, and all informal meetings and consultations of the Subcommittee and its working groups held during the work schedule of the Subcommittee should be provided with interpretation services;

(i) The Chairman should set a deadline for closing lists of speakers for the general exchange of views and for each of the substantive agenda items;

(j) The Subcommittee and its working groups should begin their morning meetings at 10 a.m. with the understanding that that did not relate to and did not affect the question of the length of the session;

(k) When adopting and following the schedule of work, the Subcommittee should exercise flexibility in the allocation of time for consideration of items on its agenda. If the time previously allocated for the consideration of an item was not fully used or was unlikely to be used, the Subcommittee should seek, on the basis of consensus, to use the time for the consideration of other items on the agenda or, as the case might be, consider the possibility of concluding the session ahead of the scheduled date. The adoption of that measure was without prejudice to the position of various delegations concerning the duration of the sessions of the Subcommittee.

13. The Subcommittee agreed that a similar flexible organization of work as agreed upon at the current session would serve as the basis for organizing the work of its thirty-sixth session.

14. At its 596th meeting, on 27 March, the Chairman proposed, and the Subcommittee agreed, to conclude the session ahead of time in accordance with the measure contained in paragraph 12 (k) above. Specifically, the Subcommittee decided to conclude its work on 28 March. The Subcommittee agreed that that reduction was without prejudice to the length of its future sessions.

15. The Subcommittee agreed that, in view of its recommendation to suspend, for another year, the work of its Working Group on agenda item 3, as contained in paragraph 25 below, the following additional measures concerning organization of work could be adopted for the next session of the Subcommittee:

(a) At the 1997 session, less time should be allocated for consideration of agenda item 3 than for items 4 and 5;

(b) The recommendation of the Committee on the Peaceful Uses of Outer Space that the Legal Subcommittee, on a permanent basis, should rotate each year the order of consideration of substantive agenda items² should be suspended for the 1997 session and the substantive agenda items should be considered at that session in the following order: items 4, 5 and 3.

The adoption of the above measures is without prejudice to the positions of various delegations concerning the duration of the sessions of the Subcommittee.

16. In the course of the general exchange of views, some delegations expressed the view that an international agreement on the problem of space debris might be necessary in the future. Some delegations noted with satisfaction that the Scientific and Technical Subcommittee had continued its consideration of space debris as a priority item at its session in 1996 and had begun its multi-year work plan in order to advance in its consideration of that agenda item. Some delegations also expressed the view that it was advisable for the Legal Subcommittee to begin consideration of legal issues relating to space debris. Other delegations expressed the view that the Scientific and Technical Subcommittee needed to be given sufficient time and opportunity to adequately assess the problem of space debris appropriately before the issue could be considered by the Legal Subcommittee.

17. The Legal Subcommittee noted with satisfaction that a symposium entitled "Protection of the space environment", organized by the International Institute of Space Law and the European Centre for Space Law, both based in Paris, was held at the close of the afternoon meeting of the Legal Subcommittee on 18 March 1996.

18. The Subcommittee held a total of nine meetings. The views expressed at those meetings are summarized in documents A/AC.105/C.2/SR.589-597.

19. At its 597th meeting, on 28 March, the Subcommittee adopted the current report and concluded the work of its thirty-fifth session.

**I. QUESTION OF REVIEW AND POSSIBLE REVISION OF THE PRINCIPLES
RELEVANT TO THE USE OF NUCLEAR POWER SOURCES
IN OUTER SPACE (AGENDA ITEM 3)**

20. The Chairman made an introductory statement on agenda item 3 at the 592nd meeting, on 21 March 1996.

21. The Chairman drew attention to the fact that the General Assembly, in its resolution 50/27, had endorsed the recommendation of the Committee on the Peaceful Uses of Outer Space that the Subcommittee should continue its consideration of the question of review and possible revision of the Principles Relevant to the Use of Nuclear Power Sources in Outer Space.

22. The Legal Subcommittee noted that the subject of the use of nuclear power sources in outer space had been considered by the Scientific and Technical Subcommittee at its thirty-third session, in 1996, as reflected in the report of that Subcommittee (A/AC.105/637, paras. 69-81). In particular, the Legal Subcommittee noted that the Scientific and Technical Subcommittee had agreed that, at the present time, revision of the Principles was not warranted (A/AC.105/637, para. 70).

23. As mentioned in paragraph 8 above, the Legal Subcommittee, at its 589th meeting, decided not to re-establish its Working Group on agenda item 3.

24. The Legal Subcommittee agreed that, at the present time, revision of the Principles was not warranted and that therefore it should not open discussion of that item during its current session.

25. The Legal Subcommittee also agreed that, at its thirty-sixth session, consideration by the Working Group on agenda item 3 of the Principles Relevant to the Use of Nuclear Power Sources in Outer Space should again be suspended for one year, pending the results of the work in the Scientific and Technical Subcommittee, without prejudice to the possibility of reconvening its Working Group on that item if, in the opinion of the Legal Subcommittee, sufficient progress was made in the Scientific and Technical Subcommittee at its thirty-fourth session, in 1997, to warrant the reconvening of the Working Group.

26. The Legal Subcommittee agreed that that item should be retained on its agenda to give delegations an opportunity to discuss it in plenary meetings.

**II. MATTERS RELATING TO THE DEFINITION AND DELIMITATION OF OUTER SPACE
AND TO THE CHARACTER AND UTILIZATION OF THE GEOSTATIONARY ORBIT,
INCLUDING CONSIDERATION OF WAYS AND MEANS TO ENSURE THE
RATIONAL AND EQUITABLE USE OF THE GEOSTATIONARY ORBIT
WITHOUT PREJUDICE TO THE ROLE OF THE INTERNATIONAL
TELECOMMUNICATION UNION (AGENDA ITEM 4)**

27. The Chairman made an introductory statement on agenda item 4 at the 589th meeting, on 18 March 1996. He referred to the work of the Subcommittee at its thirty-fourth session, in 1995.
28. The Chairman drew attention to the fact that the General Assembly, in its resolution 50/27, had endorsed the recommendation of the Committee on the Peaceful Uses of Outer Space that the Subcommittee, taking into account the concerns of all countries, particularly those of developing countries, should continue, through its working group, its consideration of matters relating to the definition and delimitation of outer space and to the character and utilization of the geostationary orbit, including consideration of ways and means to ensure the rational and equitable use of the geostationary orbit without prejudice to the role of the International Telecommunication Union.
29. The Legal Subcommittee noted that the subject of the geostationary orbit had been under consideration in the Scientific and Technical Subcommittee at its thirty-third session, in 1996, as reflected in the report of that Subcommittee (A/AC.105/637, paras. 153-160).
30. The Legal Subcommittee had before it working papers submitted at its previous sessions under that agenda item. The Subcommittee also had before it a working paper entitled "Some considerations concerning the utilization of the geostationary satellite orbit" (A/AC.105/C.2/L.200 and Corr.1), submitted at its current session by the delegation of Colombia and set out in annex III, section A, of the present report.
31. At its thirty-fourth session, the Legal Subcommittee had finalized the text of a questionnaire on possible legal issues with regard to aerospace objects (A/AC.105/607 and Corr.1, annex I, appendix) and had agreed that the purpose of the questionnaire was to seek the preliminary views of States members of the Committee on the Peaceful Uses of Outer Space on various issues relating to aerospace objects (A/AC.105/607 and Corr.1, para. 38). At its current session, the Subcommittee had before it a document entitled "Questionnaire on possible legal issues with regard to aerospace objects: replies from Member States" (A/AC.105/635 and Add.1 and 2).
32. The views expressed by delegations during the debate on agenda item 4 are contained in summary records A/AC.105/C.2/SR.589-592.
33. As mentioned in paragraph 8 above, the Subcommittee, at its 589th meeting, re-established its Working Group on agenda item 4 under the chairmanship of Mr. Curia, the representative of Argentina.
34. At the 597th meeting, on 28 March, the Chairman of the Working Group reported to the Subcommittee. The Subcommittee took note with appreciation of the report, which is set out in annex I to the present report.
35. The Subcommittee endorsed the recommendations of the Working Group that the Secretariat should encourage those States members of the Committee on the Peaceful Uses of Outer Space who wished to submit replies to do so as early as possible; that the Secretariat should prepare in time for the thirty-sixth session of the Legal Subcommittee a comprehensive analysis of the replies to the questionnaire that had been received, in order to assist the Working Group in its deliberations; and that the Secretariat, in cooperation

with the ITU secretariat, should provide, for the next session of the Working Group, an analysis of the compatibility of the approach contained in working paper A/AC.105/C.2/L.200 and Corr.1 with the existing rules and procedures of ITU relating to the use of the geostationary orbit.

**III. CONSIDERATION OF THE LEGAL ASPECTS RELATED TO THE APPLICATION
OF THE PRINCIPLE THAT THE EXPLORATION AND UTILIZATION OF
OUTER SPACE SHOULD BE CARRIED OUT FOR THE BENEFIT
AND IN THE INTERESTS OF ALL STATES, TAKING INTO
PARTICULAR ACCOUNT THE NEEDS OF DEVELOPING
COUNTRIES (AGENDA ITEM 5)**

36. The Chairman made an introductory statement on agenda item 5 at the 594th meeting, on 25 March 1996. He referred to the work of the Subcommittee at its thirty-fourth session, in 1995.

37. The Chairman drew attention to the fact that the General Assembly, in its resolution 50/27, had endorsed the recommendation of the Committee on the Peaceful Uses of Outer Space that the Subcommittee, taking into account the concerns of all countries, particularly those of developing countries, should continue, through its working group, its consideration of the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interests of all States, taking into particular account the needs of developing countries.

38. The Subcommittee had before it a working paper entitled "Consideration of the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interests of all States, taking into particular account the needs of developing countries" (A/AC.105/C.2/L.182/Rev.3), submitted at its current session by the delegations of Brazil, Chile, Colombia, Cuba, Egypt, Iraq, Mexico, Nigeria, Pakistan, Philippines, Uruguay and Venezuela. The Subcommittee also had before it a working paper entitled "Declaration on international cooperation in the exploration and use of outer space for the benefit and in the interests of all States, taking into particular account the needs of developing countries" (A/AC.105/C.2/L.197/Rev.1), submitted at its current session by the delegations of France and Germany. Those working papers are set out in annex III, sections B and C, of the present report. In addition, the Subcommittee had before it an informal working paper entitled "Declaration of principles regarding international cooperation in the exploration and utilization of outer space for peaceful purposes for the benefit and in the interests of all States, taking into particular account the needs of developing countries" (A/AC.105/C.2/1995/CRP.5, as amended), submitted to the Subcommittee at its thirty-fourth session by the Chairman of the Working Group on agenda item 5. The informal working paper represented a merger based on the texts of working papers A/AC.105/C.2/L.182/Rev.2 and A/AC.105/C.2/L.197, with additional language from the Chairman. The informal working paper is set out as an appendix to annex II of the report of the Legal Subcommittee on its thirty-fourth session, in 1995 (A/AC.105/607 and Corr.1).

39. The views expressed by delegations during the debate on agenda item 5 are contained in summary records A/AC.105/C.2/SR.594-596.

40. As mentioned in paragraph 8 above, the Subcommittee, at its 589th meeting, re-established its Working Group on agenda item 5 under the chairmanship of Mr. González, the representative of Chile.

41. The Subcommittee took note of a working paper (A/AC.105/C.2/L.202), submitted by the Chairman of the Working Group on agenda item 5 and containing a consolidated text produced by the sponsors of working papers A/AC.105/C.2/L.182/Rev.3 and A/AC.105/C.2/L.197/Rev.1 as a result of extensive informal

consultations. This working paper, as revised by the Chairman on the basis of the debate in the Working Group, is set out in annex III, section D, of the present report.

42. At the 597th meeting, on 28 March, the Chairman of the Working Group on agenda item 5 reported to the Subcommittee. The Subcommittee took note with appreciation of the report, which is set out in annex II to the present report.

IV. OTHER MATTERS (AGENDA ITEM 6)

Records of the Legal Subcommittee

43. In accordance with a recommendation made by the Committee on the Peaceful Uses of Outer Space at its thirty-eighth session, in 1995,⁴ and pursuant to the request of the General Assembly in its resolution 50/27, paragraph 12, the Subcommittee reviewed its requirement for summary records with a view to determining whether it might be possible to utilize verbatim (unedited) transcripts at its subsequent sessions and to consider under what circumstances there might be a need to revert to summary records should a decision be taken to utilize verbatim (unedited) transcripts.

44. As a result of discussions held, the Subcommittee recommended that, beginning with its thirty-sixth session, in 1997, it should be provided with verbatim (unedited) transcripts of its sessions in lieu of summary records.

45. The view was expressed that once the above-mentioned recommendation was approved by the Committee on the Peaceful Uses of Outer Space and the General Assembly, it should be reflected appropriately in the relevant section of the United Nations budget.

Working methods of the Legal Subcommittee

46. The improvements in the working methods of the Legal Subcommittee achieved through the flexible approach to its work schedule were generally recognized. Some delegations, however, expressed the view that further improvements were necessary. Some of those delegations believed that the work schedule of the Subcommittee should be further rationalized following the example of other United Nations bodies meeting at Vienna. The view was also expressed that the scheduled length of each session of the Subcommittee should be two weeks and that, if necessary, the session could be extended on an ad hoc basis.

47. Other delegations opposed the reduction of the duration of sessions of the Legal Subcommittee, regarding such a reduction as unnecessary, particularly in view of the flexible measures applied in the work of the Subcommittee. They believed that the consideration of any possible reduction of the duration of the sessions of the Legal Subcommittee should not detract from the consideration of substantive new items that were currently being considered by the Subcommittee or that could be placed on its agenda in the future. Those delegations also expressed the view that a thorough examination of the possibility of adding new items to the agenda should be undertaken before taking any decision on reducing the duration of the sessions of the Legal Subcommittee.

48. The view was expressed that, while some perhaps believed that in the future activities in outer space would increasingly be regulated by "market forces", intergovernmental regulation of outer space activities and the development of outer space law would continue to be of paramount importance and that, therefore, the role of the Legal Subcommittee should be strengthened and the question of the duration of the sessions of the Subcommittee should be approached with that in mind.

49. Some delegations, while noting that progress had been made in the application of flexible measures of work at the current session, expressed the view that the Committee on the Peaceful Uses of Outer Space should give due consideration to the views expressed by various delegations at the current session of the Legal Subcommittee with a view to further improving working methods of the Committee and its subsidiary bodies. In particular, those delegations believed that consideration should be given to the proposals of adopting a multi-year plan for the work of the Committee, of avoiding scheduling sessions of the Legal Subcommittee simultaneously with other bodies meeting at Vienna, and of having simultaneous plenary and working group meetings. In reply, the view was expressed that, while some of the above-mentioned proposals were beyond the competence of the Subcommittee and even the United Nations, some of the others could more appropriately be considered by the Committee, and still other proposals, such as having simultaneous plenary and working group meetings, would lead to practical difficulties for delegations consisting of only one representative.

50. Some delegations expressed the view that, while the Legal Subcommittee had perhaps gone as far as reasonably possible in rationalizing its methods of work, further improvements in the overall organization of work of the Committee on the Peaceful Uses of Outer Space and its subsidiary bodies might still be possible and desirable, and that that subject should be properly addressed by the Committee at its thirty-ninth session, in 1996.

51. In summing up the debate on agenda item 6, the Chairman expressed the view that the discussion had been useful and had assisted in providing a better understanding of the positions of various delegations. He noted that some of the ideas expressed at the current session under the agenda item were already being considered by the Working Group of the Whole established by the Committee on the Peaceful Uses of Outer Space to examine the working methods of the Committee and its subsidiary bodies.

52. The views expressed by delegations during the debate on agenda item 6 are contained in summary records A/AC.105/C.2/SR.593 and 595.

V. INFORMAL CONSULTATIONS ON NEW ITEMS FOR THE AGENDA

53. In accordance with the recommendation of the Legal Subcommittee contained in paragraph 54 of the report on its thirty-fourth session, in 1995 (A/AC.105/607 and Corr.1), the Chairman of the Subcommittee conducted informal open-ended consultations, with all members of the Subcommittee, with a view to identifying, on the basis of consensus, a subject or a list of subjects that might be considered, in the future, for inclusion in the agenda of the Subcommittee.

54. During those consultations the following items proposed by some delegations at the thirty-fourth session, in 1995 (A/AC.105/607 and Corr.1, para. 47), for possible inclusion in the agenda of the Subcommittee at its future sessions were discussed:

- (a) Status of the five outer space treaties;
- (b) Commercial aspects of space activities (e.g. property rights, insurance and liability);
- (c) Review of existing norms of international law applicable to space debris;
- (d) Legal aspects of space debris;

(e) Comparative review of the principles of international space law and international environmental law.

55. In addition, the following ideas concerning the agenda of the Legal Subcommittee, contained in the annex to the report of the Committee on the Peaceful Uses of Outer Space on its thirty-seventh session, in 1994,⁵ were discussed:

(a) Possibility of establishing, through consensus, a working agenda, comprised of items upon which substantive progress is possible;

(b) Possibility of separating the issue on definition and delimitation of outer space from the issue of the character and utilization of the geostationary orbit.

As a result of the discussion, it was felt that it was not possible to reach a consensus on those two ideas. It was agreed that further discussion on those ideas was not necessary.

56. With regard to the proposals contained in paragraph 54 (a), (c) and (e) above, the delegations of Mexico, the Czech Republic and Chile, respectively, submitted informal background notes explaining their proposals as recommended by the Legal Subcommittee at its thirty-fourth session, in 1995 (A/AC.105/607 and Corr.1, para. 55). The proposals are reproduced in annex III, sections E, F and G, of the present report.

57. At the 597th meeting, on 28 March, the Chairman reported on the results of the informal consultations.

Notes

¹ *Official Records of the General Assembly, Fiftieth Session, Supplement No. 20 (A/50/20)*, para. 189.

² *Ibid.*, *Forty-fifth Session, Supplement No. 20 (A/45/20)*, para. 143.

³ *Ibid.*, *Fiftieth Session, Supplement No. 20 (A/50/20)*, para. 188.

⁴ *Ibid.*, para. 181.

⁵ *Ibid.*, *Forty-ninth Session, Supplement No. 20 (A/49/20)*.

Annex I

REPORT OF THE CHAIRMAN OF THE WORKING GROUP ON AGENDA ITEM 4 (MATTERS
RELATING TO THE DEFINITION AND DELIMITATION OF OUTER SPACE AND
TO THE CHARACTER AND UTILIZATION OF THE GEOSTATIONARY ORBIT,
INCLUDING CONSIDERATION OF WAYS AND MEANS TO ENSURE THE
RATIONAL AND EQUITABLE USE OF THE GEOSTATIONARY ORBIT
WITHOUT PREJUDICE TO THE ROLE OF THE INTERNATIONAL
TELECOMMUNICATION UNION)

1. On 18 March 1996, the Legal Subcommittee re-established its Working Group on agenda item 4.
2. The Working Group had before it the report of the Legal Subcommittee on the work of its thirty-fourth session, in 1995 (A/AC.105/607 and Corr.1), which contained, in annex I, the report of the Chairman of the Working Group at that session. The Working Group also had before it the report of the Scientific and Technical Subcommittee on the work of its thirty-third session, in 1996 (A/AC.105/637), which considered, in chapter VII, *inter alia*, the subject of the physical nature and technical attributes of the geostationary orbit.
3. The following documents, submitted at previous sessions and at the current session of the Legal Subcommittee, were referred to in the course of the discussion: "Questions concerning the legal regime for aerospace objects", submitted to the Subcommittee at its thirty-first session by the delegation of the Russian Federation (A/AC.105/C.2/L.189); "Geostationary satellite orbit", submitted to the Subcommittee at its thirty-second session by the delegation of Colombia (A/AC.105/C.2/L.192); "Questionnaire on possible legal issues with regard to aerospace objects" (A/AC.105/C.2/1995/CRP.3/Rev.3), reproduced in the appendix of annex I to the report of the Subcommittee (A/AC.105/607 and Corr.1); and "Questionnaire on possible legal issues with regard to aerospace objects: replies from Member States" (A/AC.105/635 and Add.1 and 2).
4. The Working Group also had before it a working paper entitled "Some considerations concerning the utilization of the geostationary satellite orbit" (A/AC.105/C.2/L.200 and Corr.1), submitted by the delegation of Colombia to the Subcommittee at its current session and set out in annex III, section A, of the report of the Subcommittee.
5. On the question of the organization of its work, pursuant to a recommendation by the Chairman, the Working Group agreed that each aspect of the agenda item, namely, the definition and delimitation of outer space, on the one hand, and the geostationary orbit, on the other, should be discussed separately by the Working Group.
6. The views expressed in the discussions of the Working Group are summarized below.

The definition and delimitation of outer space

7. At the commencement of the debate, the Chairman of the Working Group referred to the document "Questionnaire on possible legal issues with regard to aerospace objects: replies from Member States" (A/AC.105/635 and Add.1 and 2). The Chairman suggested that, while delegations were free to address any aspect of the definition and delimitation of outer space, it might be useful if they could comment on the replies to the questionnaire that had been received, in order to further the work of the Working Group on that subject.

8. In response to a request made by some delegations, the Secretariat provided the Working Group with a brief overview of the replies received.
9. Some delegations expressed the view that all members of the Committee on the Peaceful Uses of Outer Space should be encouraged to submit more promptly their replies to the questionnaire in the interests of attaining progress in the work on that subject.
10. Some delegations expressed the view that the Working Group should study the replies to the questionnaire with a view to identifying possible areas of agreement. The Chairman of the Working Group noted that there had been few replies to make such an identification meaningful. The Chairman suggested, and the Working Group agreed, that it should undertake a preliminary question-by-question analysis of the replies.
11. Some delegations expressed the view that the whole issue of "definition and delimitation" was of paramount interest and importance for States and that a "responsible approach" and/or a "cautious approach" should govern the conduct of Governments when tackling the issue.
12. The view was expressed that there was no reason why replies to the questionnaire were necessary at the present time; that, in its current form, the questionnaire reflected the contradictions and uncertainties of the previous debate on the subject; that the questions were presented in an ambiguous manner and that did not serve to clarify the issue; that the questionnaire in its present form could revive the unproductive debate on the direct and topographical or indirect and functional approach to the definition and delimitation of outer space; and that such an examination of legal issues with regard to aerospace objects inevitably questioned the foundation of the law of outer space. One delegation also expressed the view that it supported the functional approach to the definition and delimitation of outer space, but that aerospace objects did not necessarily lend themselves exclusively to the functional approach.
13. The view was expressed that there was no practical or legal need to pursue the debate on a delimitation of outer space and that the questionnaire on aerospace objects in its present form was unnecessary, premature and would raise further contentious issues and was unlikely to bring about any consensus results. In the view of that delegation the debate should therefore not be continued.

Question 1

14. Some delegations expressed the view that the definition of an aerospace object given in question 1 was acceptable for working purposes but needed further refinement and clarification. The view was expressed that the notion "for a certain period of time" currently contained in question 1 should be clarified. Some delegations expressed the view that in such a definition, it should be made clear whether or not it included space debris. Some delegations expressed the view that the definition should provide only for functional, man-made objects as opposed to space debris or natural objects. Those delegations also expressed the view that the definition should take into consideration ballistic properties that govern the movements of aerospace objects in outer space. The view was expressed that in a working definition it would currently be possible to define the movement of an aerospace object through, and its presence in time in, outer space and that, in the future, additional criteria might be added. The view was expressed that the definition should also take into consideration legal elements contained in the Convention on International Liability for Damage Caused by Space Objects (General Assembly resolution 2777 (XXVI), annex) and the Convention on Registration of Objects Launched into Outer Space (General Assembly resolution 3235 (XXIX), annex) and other pertinent space law treaties related to that matter.

15. Some delegations expressed the view that the Scientific and Technical Subcommittee should first study the technical prerequisites of the question and that the Legal Subcommittee could then proceed in its work. The view was expressed that the questionnaire should also be sent to the International Civil Aviation Organization for its input on the matter.

16. The view was expressed that although the term "aerospace object" had been used in legal literature, the term "aerospace systems" might be more appropriate. In reply, the view was expressed that it would be useful to refer to terms used in legal and technical literature such as "space transportation systems" rather than introducing new terms. In reply to that, the view was expressed that the term "space transportation systems" as used in the report of the Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee had a wider meaning, covering both the transportation systems of the Space Shuttle type and the usual rocket carriers. Therefore, that term would not be appropriate for describing the hybrid systems that might be used for both air flight and missions in outer space.

Question 2

17. Some delegations believed that different air and space law regimes should apply to an aerospace object depending on where it was located at any given time. The view was expressed that it was recognized in international law that every State had complete and exclusive sovereignty over the airspace above its territory and that although a spatial boundary between airspace and outer space had yet to be established, it could be said that a functional boundary had been generally acquiesced upon since no State had objected to flights of satellites over its territory. That delegation also expressed the view that overlapping air and space law regimes might have to be applied to the flight of aerospace objects and that the registration and control of such objects might be recognized by the functional duality of both airspace and outer space.

Question 3

18. The view was expressed that there was a need for two separate sets of rules, one for craft travelling through airspace and the other for craft travelling through outer space.

Question 4

19. The view was expressed that aerospace objects should be considered as aircraft while in airspace and as spacecraft while in outer space and that the only distinction should be with regard to an aerospace object destined to operate in outer space and passing through airspace only during launching and landing.

Question 9

20. The view was expressed that the rules concerning the registration of objects launched into outer space were applicable to aerospace objects and that such objects could be subject to two different registration regimes depending on their purpose and use.

21. Some delegations expressed the hope that, by the thirty-sixth session of the Legal Subcommittee, more replies to the questionnaire would have been received from States. The Working Group recommended that the Secretariat should encourage those States members of the Committee on the Peaceful Uses of Outer Space who wished to submit replies to do so as early as possible.

22. The Working Group recommended that the Secretariat should prepare, in time for the thirty-sixth session of the Legal Subcommittee, a comprehensive analysis of the replies to the questionnaire that had been received, in order to assist the Working Group in its deliberations.

The geostationary orbit

23. The Chairman of the Working Group recalled that at a number of its previous sessions, the Legal Subcommittee considered a working paper entitled "Geostationary satellite orbit" (A/AC.105/C.2/L.192, reproduced in annex III, section A, of the report of the Legal Subcommittee on the work of its thirty-fourth session (A/AC.105/607 and Corr.1)), submitted by the delegation of Colombia. He noted that at the current session the delegation of Colombia had circulated a working paper entitled "Some considerations concerning the utilization of the geostationary satellite orbit" (A/AC.105/C.2/L.200 and Corr.1) which is set out in annex III, section A, of the report of the Subcommittee. The Chairman noted that the sponsor of the working paper had made a detailed presentation of the document at the 590th meeting of the Subcommittee.

24. Some delegations welcomed the submission of the working paper by the delegation of Colombia and expressed the view that it would help to attain progress in the work on the subject of the geostationary orbit.

25. Some delegations expressed the view that the Committee on the Peaceful Uses of Outer Space and its Legal Subcommittee had a mandate from the General Assembly to consider questions relating to the use of the geostationary orbit with a view to elaborating legal principles on the question. Some delegations also expressed the view that the work should be complementary to the activities of the International Telecommunication Union (ITU). In that connection, the view was expressed that the Committee and its Legal Subcommittee should strengthen their cooperation with ITU.

26. The view was expressed that because the geostationary orbit was an integral part of outer space, the legal regime established by the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (General Assembly resolution 2222 (XXI), annex), adequately covered activities in and related to the geostationary orbit. That delegation also believed that ITU had been successful in dealing with various aspects of the rational and equitable use of the geostationary orbit and that it was not appropriate for the Legal Subcommittee to engage in activities that might conflict with those of ITU and other international bodies.

27. The view was expressed that there was a need to establish a *sui generis* legal regime for regulating access to and the use of the geostationary orbit, which was a limited natural resource. Such a regime should guarantee equitable access to the geostationary orbit for all States, taking particular account of the needs of developing countries, including the equatorial countries due to their special characteristics. Since outer space had not so far been delimited, it could not be affirmed that the geostationary orbit was a part of outer space. That delegation considered that the new working paper submitted by Colombia was useful and that it enriched the debate in the Working Group on the geostationary orbit. In addition, that delegation noted that the special *sui generis* regime should also refer to the space debris issue.

28. The view was expressed that working paper A/AC.105/C.2/L.200 and Corr.1 should be restructured as a draft resolution to be ultimately adopted by the General Assembly. That delegation also expressed the view that the text of the draft should be divided into a preambular part and an operative annex that would contain a number of principles, including two new paragraphs: the first providing that the principles should serve as a guideline for the entire United Nations system, including ITU, with regard to the regulation of the geostationary satellite orbit; and the second relating to the settlement of disputes.

29. At the request of some delegations, the representative of ITU commented on the working paper from the perspective of ITU rules and regulations. That representative also responded to questions raised by some delegations and offered further explanations with regard to the a priori planning and coordination procedures employed by ITU, as well as resolution 18 adopted by the plenipotentiary conference of ITU, held at Kyoto, Japan, in 1994, referred to in the working paper.

30. Some delegations indicated that they would need more time to study the working paper with a view to making comments. Other delegations made the comments below with regard to the working paper.

Title

31. The view was expressed that the title of the working paper should be "Draft Principles Governing the Rational and Equitable Use of the Geostationary Satellite Orbit".

Recommendation (a)

32. The view was expressed that it was unclear what exactly the coordination procedures in the text referred to.

33. In reply, the sponsor of the working paper stated that that term referred to ITU coordination procedures as set out in the relevant ITU documents.

34. Some delegations expressed the view that the sponsor of the working paper and ITU should further coordinate their efforts in refining the text.

35. The view was expressed that the phrase "in respect of bands and services not planned by ITU" should be replaced by "in respect of bands and services not subject to a priori plans by ITU".

36. The view was expressed opposing the inclusion of notions such as developed countries and developing countries because it considered that the terms were too vague to be chosen as criteria and that the level of development of countries did not necessarily correspond to those of development in space industry; thus, the choice of such a criterion could give rise to inequitable results.

37. Some delegations expressed the view that the words "when a developed country and a developing country have equal claims to access to the same orbital position or neighbouring positions, or" should be deleted because the needs and interests of the developing countries might be better served by the words "when a country which has already had access and another which has not yet had access have equal claims". In response, the sponsor of the working paper stated that while in principle that proposal could be considered, the rationale behind using the term "developing countries" in the paper was explained by the fact that that term was used both in the relevant ITU documents and in the mandate of the Legal Subcommittee to consider questions relating to the geostationary orbit.

Recommendation (b)

38. The view was expressed that it was unclear to what the term "conditions" in the text referred.

39. In reply, the sponsor of the working paper stated that the term referred to the rules and regulations used in ITU documents.

Recommendation (c)

40. Some delegations expressed the view that, since the issue of space debris was already being considered by the Scientific and Technical Subcommittee, it was not appropriate to address the issue of space debris in the text.

41. The view was expressed that, because the problem of space debris was of particular importance to that matter, reference could be made to the term "non-functional objects" instead of "space debris".
42. In response, the sponsor of that working paper suggested that the term "space debris and" could be deleted.
43. The view was expressed that because the geostationary satellite orbit was a limited natural resource and must be used efficiently for the benefit of all humankind, it was important that efforts should be made to remove the spent satellites from the geostationary satellite orbit at the end of their useful lives.
44. At the conclusion of the debate, the sponsor of the working paper expressed his appreciation to all delegations that commented on the document and expressed the hope that those suggestions could be, in due course, communicated to him in writing so that they could be adequately taken into account.
45. The Working Group recommended that those delegations wishing to have certain provisions of working paper A/AC.105/C.2/L.200 and Corr.1 modified should consider submitting their proposals in writing, either to the sponsor or to the Working Group in the form of working papers, in order to facilitate the consideration of those proposals.
46. The Working Group recommended that the Secretariat should circulate to the delegations at the next session of the Working Group a compendium of relevant sections and/or documents referred to in working paper A/AC.105/C.2/L.200 and Corr.1 with a view to facilitating the debate on the working paper.
47. The Working Group recommended that the Secretariat, in cooperation with the ITU secretariat, should provide, for the next session of the Working Group, an analysis of the compatibility of the approach contained in working paper A/AC.105/C.2/L.200 and Corr.1 with the existing rules and procedures of ITU relating to the use of the geostationary orbit.

Annex II

REPORT OF THE CHAIRMAN OF THE WORKING GROUP ON AGENDA ITEM 5
(CONSIDERATION OF THE LEGAL ASPECTS RELATED TO THE APPLICATION OF THE PRINCIPLE THAT THE EXPLORATION AND UTILIZATION OF OUTER SPACE SHOULD BE CARRIED OUT FOR THE BENEFIT AND IN THE INTERESTS OF ALL STATES, TAKING INTO PARTICULAR ACCOUNT THE NEEDS OF DEVELOPING COUNTRIES)

1. On 18 March 1996, the Legal Subcommittee re-established its Working Group on agenda item 5.
2. The Working Group had before it the report of the Legal Subcommittee on the work of its thirty-fourth session, in 1995 (A/AC.105/607 and Corr.1), which contained, in annex II, the report of the Chairman of the Working Group on agenda item 5 at that session. It also had before it a working paper entitled "Consideration of the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interests of all States, taking into particular account the needs of developing countries" (A/AC.105/C.2/L.182/Rev.3), submitted at its current session by the delegations of Brazil, Chile, Colombia, Cuba, Egypt, Iraq, Mexico, Nigeria, Pakistan, Philippines, Uruguay and Venezuela, and a working paper entitled "Declaration on international cooperation in the exploration and use of outer space for the benefit and in the interests of all States, taking into particular account the needs of developing countries" (A/AC.105/C.2/L.197/Rev.1), submitted at its current session by the delegations of France and Germany. Those working papers are contained in annex III, sections B and C, of the present report. In addition, the Subcommittee had before it an informal working paper entitled "Declaration of principles regarding international cooperation in the exploration and utilization of outer space for peaceful purposes for the benefit and in the interests of all States, taking into particular account the needs of developing countries" (A/AC.105/C.2/1995/CRP.5, as amended), submitted to the Subcommittee at its thirty-fourth session by the Chairman of the Working Group on agenda item 5. The informal working paper represented a merger based on the texts of working papers A/AC.105/C.2/L.182/Rev.2 and A/AC.105/C.2/L.197, with additional language from the Chairman, and is set out as an appendix to annex II of the report of the Subcommittee on its thirty-fourth session, in 1995 (A/AC.105/607 and Corr.1).
3. In his introductory statement the Chairman referred to the work of the Working Group during the previous session, in 1995, outlining the extensive and productive exchange of views that had occurred on the basis of working papers A/AC.105/C.2/L.182/Rev.2 and A/AC.105/C.2/L.197, which had provided the basis for further progress on the item. He expressed the hope that, with the introduction of the revised versions of those working papers (A/AC.105/C.2/L.182/Rev.3 and A/AC.105/C.2/L.197/Rev.1), further progress could be achieved at the current session.
4. A statement was made by the delegation of Brazil on behalf of the co-sponsors of working paper A/AC.105/C.2/L.182/Rev.3. The Working Group was informed of amendments and modifications that had been made to working paper A/AC.105/C.2/L.182/Rev.2 in the light of comments expressed during the previous session. The Working Group was also informed of the history and general goals of the document and of the premises underlying the concepts contained in the working paper.
5. A statement was made by the delegation of Germany on behalf of the co-sponsors of working paper A/AC.105/C.2/L.197/Rev.1. The Working Group was informed of the amendments and modifications that had been made to working paper A/AC.105/C.2/L.197 in the light of comments expressed during the previous session. The Working Group was also informed of the general goals of the document and of the premises underlying the concepts contained in the working paper.

6. Some delegations welcomed the revisions of the two working papers and indicated their support of the proposals contained therein. They looked forward to constructive discussions that could contribute to further progress in the Working Group.

7. Some delegations expressed the view that the co-sponsors of the two working papers should attempt to combine them into one. Some delegations expressed the view that the co-sponsors should first identify the similarities and differences in their texts, eliminate controversial paragraphs and elaborate on common paragraphs, with a view to arriving at a combined text.

8. The view was expressed questioning whether there was currently a need to elaborate either principles or a declaration regarding international cooperation in the exploration and utilization of outer space for peaceful purposes, in view of the extensive international cooperative activities currently taking place.

9. On the question of the organization of its work, pursuant to a recommendation by the Chairman, the Working Group agreed that first Brazil and then Germany, on behalf of the co-sponsors of the respective working papers, would present them on a paragraph-by-paragraph basis, allowing delegations the opportunity to offer their comments and suggestions.

Working paper on consideration of the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interests of all States, taking into particular account the needs of developing countries (A/AC.105/C.2/L.182/Rev.3)

10. At the suggestion of the Chairman, the delegation of Brazil, on behalf of the co-sponsors, proceeded with a brief introduction of each preambular paragraph and each paragraph of the text set forth in the annex to working paper A/AC.105/C.2/L.182/Rev.3, in order to explain the rationale for those paragraphs, to provide some background on how they had been formulated, to highlight the changes made to the previous draft and to elicit comments from other delegations. That introduction, as well as the comments of other delegations, is set out in paragraphs 11-31 below.

Title

11. Some delegations expressed the view that the title of working paper A/AC.105/C.2/L.182/Rev.3 should be replaced with that of working paper A/AC.105/C.2/L.197/Rev.1. In reply, the view was expressed that changing the title of the draft declaration to correspond to the one contained in working paper A/AC.105/C.2/L.197/Rev.1 was acceptable, in principle, but would depend on the substance of the text contained in the annex.

Preambular paragraphs

12. The Working Group was informed that the first preambular paragraph had been modified based on comments made at previous sessions by removing references to specific articles of the Charter of the United Nations.

13. The view was expressed that the word "relevant" should be placed before the word "provisions" and that the words "pursuant to Article III of the 1967 Treaty of Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies" should be included at the end of the sentence. In reply, the view was expressed that while, in principle, inclusion of those modifications was possible, specific references had been removed in response to the concerns raised by various delegations at previous sessions.

14. The Working Group was informed that the second preambular paragraph was the same as that in working paper A/AC.105/C.2/L.182/Rev.2.

15. The Working Group was informed that the third preambular paragraph had been modified by removing references to specific General Assembly resolutions.

16. The view was expressed that the words "on principles" should be deleted as they would limit the number of applicable General Assembly resolutions to those that set out principles relating to activities in outer space.

17. The Working Group was informed that the fourth preambular paragraph was the same as that in working paper A/AC.105/C.2/L.182/Rev.2.

18. The Working Group was informed that the fifth preambular paragraph had been modified slightly by replacing the words "strengthening and further developing" with the words "facilitating the application of".

19. Some delegations expressed the view that, because the fifth preambular paragraph used language from article I of the Outer Space Treaty, it was necessary to delete the additional language "taking into particular account the special needs of developing countries" from the text as it could be regarded as amending the Outer Space Treaty. The view was also expressed that similar language was also included in the sixth preambular paragraph. In reply, the view was expressed that removal of the additional language from the fifth preambular paragraph might be acceptable as long as the concept was reflected elsewhere in the working paper.

20. The Working Group was informed that the sixth preambular paragraph had been modified to provide for the General Assembly to adopt a "declaration" rather than "principles".

21. Some delegations expressed the view that the wording of the sixth preambular paragraph should be changed to that contained in working paper A/AC.105/C.2/L.197/Rev.1.

Annex

22. With regard to paragraph 1, the Working Group was informed that it referred to article I of the Outer Space Treaty.

23. With regard to paragraph 2, the Working Group was informed that the text was the same as that contained in section I, paragraph 1, of working paper A/AC.105/C.2/L.197/Rev.1.

24. With regard to paragraph 3, the Working Group was informed that it was based on Principle I, paragraph 2, of working paper A/AC.105/C.2/L.182/Rev.2. The words "States with" had been replaced with the words "All States, particularly those with". The Working Group was also informed that the words "in outer space science and technology, and in their applications" had been removed from the text.

25. With regard to paragraph 4, the Working Group was informed that it was based on section I, paragraph 3, of working paper A/AC.105/C.2/L.197/Rev.1, but that the words "cooperation in the exploration and use of outer space" from that paragraph had been replaced with the words "participation in international cooperation". The Working Group was also informed that paragraph 4 did not reflect the second sentence of paragraph 3 of section I of working paper A/AC.105/C.2/L.197/Rev.1.

26. With regard to paragraph 5, the Working Group was informed that the subparagraphs in that paragraph were based on elements from both working papers submitted at the 1995 session.

27. With regard to paragraph 6, the Working Group was informed that the text had been edited based on both working papers and that wording in the paragraph that could imply an interference with the sovereign rights of States to enter into cooperative ventures had been removed.

28. With regard to paragraph 7, the Working Group was informed that the text was similar to Principle V, paragraph 1, in working paper A/AC.105/C.2/L.182/Rev.2 but that the words "by present and future generations" had been added to the end of the paragraph.

29. With regard to paragraph 8, the Working Group was informed that it had been drafted along the lines of section III, paragraph 2, of working paper A/AC.105/C.2/L.197/Rev.1, but that the words "as well as organizations for development aid in industrialized" had been replaced with the words "organizations for development aid, and developed". The Working Group was also informed that the words "potential of space services, *inter alia*, through the exchange of results" had been replaced with the words "appropriate use of space services and the potential of international cooperation".

30. With regard to paragraph 9, the Working Group was informed that it was the same as section III, paragraph 3, of working paper A/AC.105/C.2/L.197/Rev.1.

31. With regard to paragraph 10, the Working Group was informed that it was essentially the same as Principle IV, paragraph 2, of working paper A/AC.105/C.2/L.182/Rev.2 but that the words "be encouraged" had been added, as well as the words "and to other initiatives in the field of international cooperation".

**Working paper on a declaration on international cooperation in the exploration
and use of outer space for the benefit and in the interests of all States,
taking into particular account the needs of developing countries
(A/AC.105/C.2/L.197/Rev.1)**

32. At the suggestion of the Chairman, the delegation of Germany, on behalf of the co-sponsors, proceeded with a brief introduction of each paragraph of the text set forth in working paper A/AC.105/C.2/L.197/Rev.1, in order to explain the rationale for those paragraphs, to provide some background on how they had been formulated and to elicit comments from other delegations. That introduction, as well as the comments of other delegations, is set out in paragraphs 33-53 below.

Preambular paragraphs

33. The Working Group was informed that the addition of the preamble to the working paper was the most important change made to the document and that it provided the rationale for the working paper. Based on comments made by delegations at the previous session, the preamble reflected the constructive approach that those delegations had sought, thereby formalizing the working paper as a draft resolution to be adopted by the General Assembly. The Working Group was further informed that the preamble, in particular its first paragraph, had been modelled after the preamble in the Principles Relevant to the Use of Nuclear Power Sources in Outer Space, adopted by the General Assembly in its resolution 47/68 of 14 December 1992.

34. The view was expressed questioning the use of only the preamble of the Principles Relevant to the Use of Nuclear Power Sources in Outer Space as the model on which the preamble in the working paper had been based. That delegation was of the view that other resolutions, such as General Assembly resolution 2625 (XXV) of 24 October 1970, entitled "Declaration on Principles of International Law concerning

Friendly Relations and Cooperation among States in accordance with the Charter of the United Nations", General Assembly resolution 3362 (S-VII) of 16 September 1975, entitled "Development and international economic cooperation", and General Assembly resolution 41/65 of 3 December 1986, entitled "Principles relating to remote sensing of the Earth from outer space", could also have been used as models. The view was also expressed that article I of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (General Assembly resolution 2222 (XXI), annex, of 13 December 1966), should have been the basis of the draft resolution, with the additional text appearing in that article, "irrespective of their degree of economic or scientific development," being added to the preamble. In reply, the view was expressed that there existed different approaches to drafting preambles to texts and that the working paper was based on one of the latest approaches, that which had been employed in the Principles Relevant to the Use of Nuclear Power Sources in Outer Space. The view was expressed that only the first and last preambular paragraphs of the draft resolution had been modelled after the preamble of those Principles.

35. The Working Group was informed that the second preambular paragraph, particularly the key terms "further strengthening" and "broad and efficient collaboration", indicated the core of the subject-matter, and that the sponsors of the working paper had built upon existing international cooperation in order to reflect the experience gained by that cooperation.

36. The Working Group was informed that the third preambular paragraph reflected the change that had occurred in international cooperation and gave another important reason why the draft resolution had been formulated.

37. The view was expressed that it was not clear what was meant by international cooperation "among States and international organizations". In reply, the view was expressed that the phrase was meant to refer to cooperation among States and also to cooperation among States and international organizations.

38. The Working Group was informed that the fourth preambular paragraph reflected the growing experience in space activities by States, which brought States to an equal footing, and that the international cooperation described in the annex reflected that situation.

39. The view was expressed that the fourth preambular paragraph should be further clarified. In reply, the view was expressed that the annex was based on the changing international political situation and on past and current experiences gained in space activities. Those experiences defined the scope of international cooperation in that area, and that was expressed in the second part of the annex, in which an attempt had been made to be precise and broad at the same time, and in the draft resolution as a whole, which was based on how the space-faring nations had learned to conduct space activities for the benefit of all States.

40. With regard to the sixth preambular paragraph, the view was expressed that the phrase "irrespective of their degree of economic or scientific development" should be added after the term "interests of all States", in order to bring the text in line with article I of the Outer Space Treaty.

Annex

41. The Working Group was informed that the form of the operative part of the draft resolution, contained in the annex, had basically remained the same in the new version of the working paper, with changes being made to reflect comments made on the first draft by delegations at the previous session.

Part I

42. With regard to paragraph 1 of part I of the annex, the Chairman noted that the view had been expressed that the phrase "irrespective of their degree of economic or scientific development" should be appropriately included in the preambular paragraphs; he added that the phrase was adequately reflected in paragraph 1. That delegation expressed the view that the phrase contained in article I of the Outer Space Treaty was important in different contexts and that it was as important in the context of the preambular paragraphs as it was in the context of paragraph 1 of part I of the annex.

43. With regard to paragraph 2, the Working Group was informed that, based on comments made at the previous session, the sequence of the sentences had been altered and that the term "resources" had been rendered more precise by the use of the terms "financial" and "technical". The Working Group was also informed that paragraph 2 was one of the most important, as its goal was the efficient allocation of scarce resources.

44. Some delegations expressed the view that the term "should", which connoted conditional international cooperation, should be replaced with the term "shall", which was more appropriate. In reply, the view was expressed that the term "shall" was the term that was normally used in international treaties, which the first paragraph of the annex cited; the rest of the text was intended to be a General Assembly resolution, in which the term "should" would be more appropriate.

45. The view was also expressed that an appropriate reference should be made to the dissemination of information and transfer of technology, after the term "applications".

46. With regard to paragraph 3, the Working Group was informed that the term "shall" had been replaced by the term "should", in order to make the text more precise.

Part II

47. The Working Group was informed that part II of the annex covered all possible aspects of international cooperation in the field of outer space and that it reflected the fact that both working papers currently before the Working Group had the same goals, making space technology and applications part of development strategies for States.

48. With regard to paragraph 2, the view was expressed that the reference to "financial and technical resources" was repetitive, in that it appeared in part I of the annex, which laid out the general elements of international cooperation, and therefore could be deleted from the second part. The view was also expressed that the reference to "financial and technical resources" should be maintained in view of ensuring the most effective and appropriate mode of cooperation. The view was further expressed that the criteria laid down in paragraph 2 gave the impression that the concept of "free choice", reflected in part II, paragraph 1, no longer applied and that, since international cooperation depended on the actual needs of the parties concerned, it was necessary to reflect that idea in the paragraph. The view was further expressed that the term "should" could be replaced by the term "shall". In reply, the view was expressed that the term "shall" would hinder free choice in selecting modes of cooperation.

49. The view was expressed that the sentence in paragraph 2 could be replaced by the following sentence: "States are free to determine all aspects of cooperation".

50. With regard to paragraph 3, the view was expressed that it was not clear what the phrase "consistency between national and international space activities" meant. In reply, the view was expressed that, in the first

place, the phrase did not refer to any legal principle and, secondly, it meant that the national activities that States conducted should not duplicate and overlap their international cooperative activities.

Part III

51. With regard to paragraph 1, the view was expressed that the reference to international law, the Charter of the United Nations and the Outer Space Treaty was redundant, since the reference had already been made, and should therefore be deleted. The view was also expressed that the reference should be retained even if it was redundant, because its deletion could cause confusion and controversy.

52. With regard to paragraph 3, some delegations expressed the view that the role of the Committee on the Peaceful Uses of Outer Space was not accurately reflected, since that body was more than a forum for the mere exchange of information on national and international space activities. They stated that the role of the Committee was not thus limited, since its mandate, both in the General Assembly resolutions on its establishment and in subsequent General Assembly resolutions, included other important tasks, such as the development of space law, that could also be reflected in paragraph 3, as well as in the identical paragraph in working paper A/AC.105/C.2/L.182/Rev.3. Those delegations expressed the view that paragraph 3 should be replaced with the following new paragraph:

"The United Nations Committee on the Peaceful Uses of Outer Space should be strengthened in its role as a forum for the promotion of international cooperation and other activities in the field of the exploration and peaceful uses of outer space."

In reply, the view was expressed that the General Assembly resolutions on the establishment of the Committee had been general in nature, which went beyond the current task of the Working Group on agenda item 5. In addition, the paragraph included the word "as", which indicated a greater, and not restricted, role for the Committee. The view was expressed that the phrase "as a forum" was limiting in nature and that the phrase "among others" should be inserted after the term "role".

53. The Chairman of the Working Group expressed the view that the submission of the revised versions of working papers A/AC.105/C.2/L.182/Rev.3 and A/AC.105/C.2/L.197/Rev.1 constituted an important step forward in the development of the debate in the Working Group. The discussion on item 5 of the agenda, both in the plenary and in the Working Group, in particular the exchange of views between the co-sponsors of the two working papers, had significantly expanded the terms of reference of the debate. The working papers represented an extremely constructive effort and, with additional work, a common understanding and consensus could be reached. The Chairman urged the sponsors of both working papers to enter into informal consultations in an attempt to produce a combined text.

Working paper submitted by the Chairman of the Working Group (A/AC.105/C.2/L.202)

54. As a result of those consultations, the Chairman submitted a working paper entitled "Working paper submitted by the Chairman of the Working Group" (A/AC.105/C.2/L.202), which is set out in annex III, section D, to the present report.

55. The Chairman, while introducing the working paper, stated that it was the outcome of efforts made to consolidate the ideas presented in working papers A/AC.105/C.2/L.182/Rev.3 and A/AC.105/C.2/L.197/Rev.1. He added that agreement could not be reached on some elements of the text and that those elements had therefore been placed in square brackets. Some delegations welcomed the introduction of the Chairman's working paper which, in their view, would lead to progress in the work of the

Subcommittee on agenda item 5. The Chairman invited delegations to comment on the working paper. Those comments are set out in paragraphs 56-70 below.

Preambular paragraphs

56. With regard to the third preambular paragraph, some delegations expressed the view that it would be desirable to refer to other international agreements and principles relating to outer space, in addition to the Outer Space Treaty. The view was expressed that while the third preambular paragraph could indeed refer to other outer space agreements, the proper place to refer to principles relating to outer space would be the fourth preambular paragraph.

57. With regard to the fourth preambular paragraph, the view was expressed that it was necessary to add "of States" after "activities".

58. With regard to the fifth preambular paragraph, the view was expressed that the reference to "other international conferences" was questionable. The view was also expressed that that reference was missing in the French version of the report and that the solution might be either to conform the French version to the versions in the other languages or to delete the reference everywhere.

59. With regard to the seventh preambular paragraph, some delegations expressed the view that the term "made" should be replaced with either the term "gathered" or the term "gained".

60. With regard to the ninth preambular paragraph, the view was expressed that the word "all" should be added before the word "mankind".

Annex

61. With regard to paragraph 1, the view was expressed that in the second sentence the word "it" should be replaced with the phrase "international cooperation". Some delegations expressed the view that in the last sentence the term "should" should be replaced with the term "shall". In reply, the view was expressed that the use of the term "should" should be retained.

62. With regard to paragraph 2, the view was expressed that the term "should" should be replaced by the term "shall". The view was expressed that while the choice of the term "shall" or "should" in past documents on outer space was subject to long and difficult debate, it was necessary to keep in mind that in the formulation of the title of the agenda item under review, as mandated by the General Assembly, the term "should" had been used.

63. With regard to paragraph 3, the view was expressed that in the first sentence the term "utilization" should be replaced with the term "use" in order to conform to the relevant formulation of the Outer Space Treaty and that in the second sentence the words "for and in the" should be replaced with the word "and". Some delegations expressed the view that in the second sentence, after the words "should be given", the words "to the principle that the exploration and use of outer space shall be carried out for the benefit" should be inserted and that the current words "to the benefit for" should be deleted.

64. With regard to paragraph 4, the view was expressed that the current wording of the paragraph, especially its ending, was somewhat overly complicated and could be better edited.

65. With regard to paragraph 5, the view was expressed that the words "rational and" should be added after "considering the" and that the words "financial and technical" should be added after "allocation of". The

view was also expressed that the words "the need for technical assistance and" should be added before the words "efficient allocation of resources".

66. The view was expressed that the elements of cooperation contained in part III, paragraph 1, of working paper A/AC.105/C.2/L.197/Rev.1 should be added to the list of goals contained in that paragraph.

67. With regard to paragraph 6, some delegations expressed the view that the square brackets around the text should be removed because the mandate given to the Subcommittee by the General Assembly was wide enough to deal with the issues of preserving the space environment. In reply, other delegations expressed the view that that mandate did not specifically refer to environmental issues, that the current formulation of the paragraph did not even refer to international cooperation, which was the objective of the work under agenda item 5 and that article IX of the Outer Space Treaty referred to the environment of the Earth and not to the space environment. In reply, some delegations expressed the view that article IX should not be interpreted so narrowly. The view was expressed that the words "not to hinder" should be replaced with the words "to preserve". The view was also expressed that the word "activities" should be replaced with the word "cooperation". In reply, the view was expressed that that formulation might be viewed as a revision of the relevant provisions of the Outer Space Treaty.

68. With regard to paragraph 8, the view was expressed that that paragraph should be replaced with the formulation proposed with regard to part III, paragraph 3, of working paper A/AC.105/C.2/L.182/Rev.3 (see paragraph 52 above). The view was also expressed that the words "cooperation for" should be replaced with the words "international cooperation in".

69. With regard to the working paper as a whole, the view was expressed questioning the need or tangible benefit of the declaration proposed in the working paper and the legal and practical implications of such a document, which should be carefully considered in the light of clear provisions contained in article I of the Outer Space Treaty. That delegation nevertheless appreciated the efforts invested by participants of the informal consultations in the production of the working paper and stated that it was looking forward to continued consideration of the document and the ideas behind it.

70. In summing up the debate, the Chairman expressed the view that the production of the consolidated text by sponsors of working papers A/AC.105/C.2/L.182/Rev.3 and A/AC.105/C.2/L.197/Rev.1 was an extremely positive development, greatly facilitating the progress of the work on agenda item 5. The Chairman informed the Working Group that he would make minor amendments enhancing the consolidated text taking into account the views expressed by various delegations during the debate and that the revised text would be annexed to the report of the Subcommittee (see annex III, section D, of the report of the Subcommittee). The Chairman expressed the view that that text would become a basis for achieving further progress on agenda item 5 and he expressed the hope that the document could be finalized in the near future.

71. The Working Group held its final meeting on 28 March 1996, when it considered and approved the present report.

Annex III

DOCUMENTS ANNEXED TO THE REPORT

A. Matters relating to the definition and delimitation of outer space and to the character and utilization of the geostationary orbit, including consideration of ways and means to ensure the rational and equitable use of the geostationary orbit without prejudice to the role of the International Telecommunication Union

Working paper submitted by Colombia (A/AC.105/C.2/L.200 and Corr.1 of 15 March 1996)

Some considerations concerning the utilization of the geostationary satellite orbit

I. In paragraph 4 of resolution 50/27, the General Assembly:

“Endorses the recommendations of the Committee that the Legal Subcommittee, at its thirty-fifth session, taking into account the concerns of all countries, particularly those of developing countries, should:

(a) ...

(b) Continue, through its working group, its consideration of matters relating to the definition and delimitation of outer space and to the character and utilization of the geostationary orbit, including consideration of ways and means to ensure the rational and equitable use of the geostationary orbit without prejudice to the role of the International Telecommunication Union” (our underlining).

In paragraph 6 of the same resolution, the Assembly “Notes that deliberations on the question of the geostationary orbit have been undertaken by the Legal Subcommittee as reflected in its report, on the basis of recent proposals which might provide a new and enhanced basis for future work”, and on this point refers to the *Official Records of the General Assembly, Fiftieth Session, Supplement No. 20 (A/50/20)*, Sect. II.C (our underlining).

In paragraph 17, it

“Also endorses the recommendations of the Committee that the Scientific and Technical Subcommittee, at its thirty-third session, taking into account the concerns of all countries, particularly those of developing countries, should (our underlining):

“(a) Consider the following items on a priority basis:

“... ”

“(ii) Examination of the physical nature and technical attributes of the geostationary orbit and of its utilization and applications, including, *inter alia*, in the field of space communications, as well as other questions relating to space communications developments, taking particular account of the needs and interests of developing countries” (our underlining).

Examination of the above texts shows in a clear and irrefutable way:

(a) The competence of the Committee and its subcommittees to examine and comment on the subject of the geostationary satellite orbit, without prejudice to the role of the International Telecommunication Union, but also without renouncing that competence in any way;

(b) That the General Assembly wishes the subject to be considered and that such consideration should ensure the rational and equitable use of the geostationary satellite orbit;

(c) That the subject should continue to be considered, *inter alia*, taking into account the concerns of all countries, particularly those of developing countries;

(d) That the General Assembly has noted the consideration that was given to the subject in the Legal Subcommittee on the basis of recent proposals which might provide a new and enhanced basis for future work, and that there is a reference to the relevant documents, among which is the one submitted by Colombia on this matter, as follows from the references and the manner in which the negotiations and the deliberations on the subject in the General Assembly proceeded.

II. The Constitution of the International Telecommunication Union states in chapter VII, article 44, No. 196 paragraph 2, that:

"In using frequency bands for radio services, Members shall bear in mind that radio frequencies and the geostationary-satellite orbit are limited natural resources and that they must be used rationally, efficiently and economically, in conformity with the provisions of the Radio Regulations, so that countries or groups of countries may have equitable access to both, taking into account the special needs of the developing countries and the geographical situation of particular countries" (our underlining).

The international norm quoted indicates expressly:

(a) That the geostationary satellite orbit is a limited natural resource;

(b) That it must be used rationally, efficiently and economically;

(c) That equitable access to this orbit must be permitted;

(d) That in order to permit this equitable access account must be taken of the special needs of the developing countries and the geographical situation of particular countries.

III. The International Telecommunication Union (ITU), through the Radio Regulations, has been setting guidelines for the use of the geostationary satellite orbit and radio frequencies in accordance with the principles in article 44 of the present Constitution, which reproduces the texts of other international instruments such as the Nairobi Convention of 1992.

Since 1977, orbital positions, frequencies and services in the geostationary orbit have been planned so as to guarantee in this manner equitable access for all countries.

At the present time the frequency bands and services planned for which countries have been allotted orbital positions are as follows:

<i>Services</i>	<i>ITU Conferences</i>	<i>Frequency bands</i>
Fixed-satellite	WARC-ORB 88	4500-4800 MHz 6725-7025 MHz 10.70-10.95 GHz 11.20-11.45 GHz 12.75-13.25 GHz
Broadcasting-satellite	WARC-1977 RARC 83 WARC-ORB 85 } WARC-ORB 88 }	11.7-12.5 GHz 12.2-12.7 GHz 17.3-17.8 GHz 14.5-14.8 GHz 17.3-18.1 GHz

Consequently, since there are already universally accepted regulations for the above-listed services and bands, we consider that any new regulations should not affect this situation.

Nevertheless, still unplanned, for the purpose of allotting geostationary orbital positions, are a large number of frequency bands and services with regard to which we feel that some more precise indications should be given in order to guarantee equitable access to the geostationary orbit, in accordance with the above-mentioned legal mandates.

Access to the geostationary satellite orbit in the unplanned bands and services is governed at the present time by the principle of "first come, first served". This procedure could be considered an inequitable procedure when it is a question of the possibility of access to a specific orbital position, at the same time and with the use of the same frequencies by the developing countries and developed countries, or by countries which have not yet had access to the orbit as against those which have. At the present time, to resolve the problems that this situation gives rise to, there are coordination procedures which might cause extensive and costly operational limitations that are to the detriment of developing countries, which the international norms in force seek to protect.

This is the reason why we put forward the proposals to be found in paragraph 9 of document A/AC.105/C.2/L.192 of 30 March 1993.

Nevertheless, in the light of the discussions that have been held in this Subcommittee and bearing in mind the fact that any declaration on this point within the United Nations should be made "without prejudice to the role of the International Telecommunication Union", we take the opportunity to suggest that these principles should be applied to those frequency bands and services which have not yet been planned by ITU.

In line with this, we consider that any regulations on this subject should simplify the process of coordination by permitting the registration of satellites of developing countries or countries that have not yet had access to the orbit in preference to those that are already using it.

Finally, we consider that any pronouncement on the subject of the geostationary satellite orbit should refer also to the question of space debris interfering with the effective use of the orbit, and that a provision on this point should therefore be added.

To conclude, we consider that a draft text prepared by this Legal Subcommittee directed towards solving the problems discussed here in accordance with international norms should contain, basically, the following elements:

CONSIDERATIONS

1. The recognition that, in accordance with article 44 of the Constitution of the International Telecommunication Union, the geostationary satellite orbit and radio frequencies are limited natural resources that must be used rationally, efficiently, economically and equitably, taking into account the special needs of the developing countries and the geographical situation of particular countries;
2. The recognition that such equitable access to radio frequencies and to the geostationary satellite orbit must be guaranteed in practice;
3. The recognition that ITU has planned the use of certain frequency bands and services, guaranteeing orbital positions and frequencies to the various countries in the geostationary satellite orbit;
4. The recognition that there are extensive bands of frequencies and services that have not been subject to planning and that access to the orbit and to the frequencies for these services takes place in accordance with the principle of "first come, first served", derived from the regulations in force;
5. The recognition that, at the present time, the regulations concerning access to frequencies and the geostationary satellite orbit in respect of bands and services that have not been subject to planning by ITU may give rise to a series of situations involving difficult processes of coordination among countries, which could eventually lead to costly operational restrictions, especially for the developing countries, that would hamper and might even prevent the access of these countries to such resources;
6. The recognition that space debris plays a part in hindering the effective and rational use of the geostationary satellite orbit.

RECOMMENDATIONS

The following principles should be recommended:

(a) When the need arises for processes of coordination between countries, due to possible radio-electronic interference in respect of bands and services not planned by ITU using geostationary satellites, the countries involved in such coordination processes shall take into account the fact that access to the geostationary satellite orbit must take place, *inter alia*, in an equitable manner and that, consequently, when a developed country and a developing country have equal claims to access to the same orbital position or neighbouring positions, or when a country which has already had access and another which has not yet had access have equal claims, the developed country or the country which has already had access to the geostationary orbit shall, in the coordination procedure, offer all possibilities for the other country to have access to the orbital position and the frequencies desired, or have such access with the minimum of operational restrictions possible;

(b) The claim of countries to use frequencies and to occupy geostationary orbital positions in the cases provided for above shall be exercised under the conditions set forth in the ITU Radio Regulations and, in any event, account shall be taken of the provisions of Resolution 18 of the 1994 Kyoto Conference to guarantee effective use of the geostationary orbit;

(c) Best efforts shall be made by the satellite "launching State" to remove space debris and spent satellites from the geostationary satellite orbit to disposal orbits shortly before the end of the useful lives of satellites, in order to ensure the effective and economical use of this orbit.

B. Consideration of the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interests of all States, taking into particular account the needs of developing countries

Working paper: Germany and France (A/AC.105/C.2/L.197/Rev.1 of 19 March 1996)

Draft resolution

Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interests of All States, Taking into Particular Account the Needs of Developing Countries

The General Assembly,

Having considered the report of the Committee on the work of its ____ session and the text of the Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interests of All States, Taking into Particular Account the Needs of Developing Countries as approved by the Committee and annexed to this report,

Convinced of the necessity and the significance of further strengthening international cooperation in order to reach a broad and efficient collaboration in this field for the mutual benefit and in the interests of all parties involved,

Recognizing the growing scope and significance of international cooperation among States and international organizations in the exploration and use of outer space for peaceful purposes,

Considering the practical experiences in international cooperative ventures, drawn by States with appropriate space capabilities and programmes in this field,

Bearing in mind the recommendations as contained in the report of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space of August 1982,

Adopts the Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interests of All States, Taking into Particular Account the Needs of Developing Countries set forth in the annex to the present resolution.

ANNEX

Declaration on international cooperation in the exploration and use of outer space for the benefit and in the interests of all States, taking into particular account the needs of developing countries

I. General elements of international cooperation

1. International cooperation in the exploration and use of outer space for peaceful purposes (hereafter "international cooperation") shall be conducted in accordance with the provisions of international law, including the Charter of the United Nations and the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies. It shall be carried out for the benefit and in the interests of all States, irrespective of their degree of economic, social or scientific and technological development, taking into particular account the needs of developing countries.
2. International cooperation should promote the development of space science, technologies and applications, taking into particular account the needs of developing countries. It should strive to allocate financial and technical resources efficiently.
3. States are free to determine all aspects of their cooperation in the exploration and use of outer space on an equitable and mutually acceptable basis. By all means, contractual terms in such cooperative ventures should be fair and reasonable. They should be in full compliance with the legitimate rights and interests of the parties concerned as, for example, with intellectual property rights.

II. Modes of cooperation

1. States are free to choose among different modes of cooperation, namely, between governmental or non-governmental cooperation, which can be effected on a global, regional or bilateral level. International cooperation can be carried out between industrialized and developing countries as well as among developing countries, including those with appropriate space capabilities or programmes, and among industrialized countries. All these activities can be effected on a commercial as well as on a non-commercial basis.
2. States should choose the most effective and appropriate mode of cooperation among these alternatives with the aim of an efficient allocation of financial and technical resources.
3. International cooperation should be based on durable, balanced and complementary foundations bearing in mind, *inter alia*, the consistency between national and international space activities. Thereby States can mutually benefit from international cooperation. This involves the sharing of experiences and learning together, taking into particular account the demand for special training and education activities. Cooperation should intensify and become more productive as countries, working together over a period of time, discover the benefits of such cooperation and develop mechanisms for reaching their common goal.

III. Areas of cooperation

1. Activities involving the exploration and peaceful use of outer space which are conducted in accordance with the provisions of international law, including the Charter of the United Nations and the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies, can be considered for international cooperation according to sections I and II above. Such activities are, for example:

(a) Remote sensing of the Earth from outer space including the observation of the Earth environment, management of natural and agricultural resources, oceanographic and meteorological observation and the prevention of natural disasters;

(b) The use of telecommunication services, including the improvement of the communications infrastructure in the fixed as well as mobile services, navigation and education services;

(c) Microgravity research and life science;

(d) Further manned and unmanned space exploration.

2. National and international agencies, research institutions, as well as organizations for development aid in industrialized and developing countries alike should consider the potential of space services, *inter alia* through the exchange of results and data for reaching their development goals.

3. The United Nations Committee on the Peaceful Uses of Outer Space should be strengthened in its role as a forum for the exchange of information on national and international activities in the field of cooperation for the exploration and use of outer space.

C. Consideration of the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interests of all States, taking into particular account the needs of developing countries

Working paper: Brazil, Chile, Colombia, Cuba, Egypt, Iraq, Mexico, Nigeria, Pakistan, Philippines, Uruguay and Venezuela (A/AC.105/C.2/L.182/Rev.3 of 22 March 1996)

Consideration of the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interest of all States, taking into particular account the needs of developing countries

The General Assembly,

Bearing in mind the provisions of the Charter of the United Nations,

Recalling the provisions of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (hereafter "Outer Space Treaty"),

Recalling also the relevant General Assembly resolutions on principles relating to activities in outer space,

Recalling also the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, and of other relevant international conferences on this subject,

Desirous of facilitating the application of the principle that the exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interest of all countries, irrespective of their degree of economic or scientific development, and shall be the province of mankind, and also taking into particular account the special needs of the developing countries,

Adopts the declaration on the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interest of all States, taking into particular account the needs of developing countries, set forth in the annex to the present resolution.

ANNEX

Declaration on the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interest of all States, taking into particular account the needs of developing countries

1. In accordance with the provisions of the Outer Space Treaty, the exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interest of all countries, irrespective of their degree of economic and scientific development, and shall be the province of all mankind.
2. International cooperation in the exploration and use of outer space for peaceful purposes (hereafter "international cooperation") shall be conducted in accordance with the provisions of international law, including the Charter of the United Nations and the Outer Space Treaty, and shall be carried out for the benefit and in the interest of all States, irrespective of their degree of economic, social, scientific and technological development, taking into particular consideration the needs of developing countries.
3. All States, particularly those with relevant space capabilities and with programmes for the exploration and utilization of outer space, should contribute to promoting and fostering international cooperation.
4. States are free to determine all aspects of their participation in international cooperation on an equitable and mutually acceptable basis.
5. International cooperation, while taking into particular account the needs of developing countries, should aim, *inter alia*, at the following goals:
 - (a) Promoting the development of space science and technology and of its applications;
 - (b) Fostering the development of relevant and appropriate space capabilities in interested States;
 - (c) Facilitating the exchange of expertise and technology among States;
 - (d) Allocating resources efficiently.
6. International cooperation should be conducted in the modes that are considered most effective and appropriate by the countries concerned, including, *inter alia*, governmental and non-governmental; commercial and non-commercial; global, multilateral, regional or bilateral; and among countries in all levels of development. In this context, special attention should be given to the benefits, for developing countries and countries with incipient space programmes, deriving from international cooperation with countries with more advanced space capabilities, within a fair, reasonable and mutually acceptable basis.
7. All States should pursue their activities in outer space with due regard to the need to preserve the space environment, in such a way as not to hinder its continued exploration and utilization by present and future generations.

8. National and international agencies, research institutions, organizations for development aid, and developed and developing countries alike should consider the appropriate use of space services and the potential of international cooperation for reaching their development goals.

9. The Committee on the Peaceful Uses of Outer Space should be strengthened in its role as a forum for the exchange of information on national and international activities in the field of cooperation for the exploration and use of outer space.

10. All States should be encouraged to contribute to the programme on space applications and to other initiatives in the field of international cooperation in accordance with their space capabilities and their participation in the exploration and use of outer space.

D. Consideration of the legal aspects related to the application of the principle that the exploration and utilization of outer space should be carried out for the benefit and in the interests of all States, taking into particular account the needs of developing countries

**Working paper submitted by the Chairman of the Working Group
(A/AC.105/C.2/L.202 of 27 March 1996)**

Draft resolution

[Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interests of All States, Taking into Particular Account the Needs of Developing Countries]

The General Assembly,

Having considered the report of the Committee on the work of its ___ session and the text of the "Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interests of All States, Taking into Particular Account the Needs of Developing Countries" as approved by the Committee and annexed to this report,

Bearing in mind the relevant provisions of the Charter of the United Nations,

Recalling notably the provisions of the Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies,

Recalling also the relevant General Assembly resolutions relating to activities in outer space,

Bearing in mind the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, and of other international conferences relevant in this field,

Recognizing the growing scope and significance of international cooperation among States and between States and international organizations in the exploration and use of outer space for peaceful purposes,

Considering experiences gained in international cooperative ventures,

Convinced of the necessity and the significance of further strengthening international cooperation in order to reach a broad and efficient collaboration in this field for the mutual benefit and in the interests of all parties involved,

Desirous of facilitating the application of the principle that the exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind,

Adopts the [Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interests of All States, Taking into Particular Account the Needs of Developing Countries] set forth in the annex to the present resolution.

ANNEX

[Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interests of all States, Taking into Particular Account the Needs of Developing Countries]

1. International cooperation in the exploration and use of outer space for peaceful purposes (hereafter "international cooperation") shall be conducted in accordance with the provisions of international law, including the Charter of the United Nations and the Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies. It shall be carried out for the benefit and in the interests of all States, irrespective of their degree of economic, social or scientific and technological development, and shall be the province of all mankind. Particular account should be taken of the needs of developing countries.
2. States are free to determine all aspects of their participation in international cooperation in the exploration and use of outer space on an equitable and mutually acceptable basis. Contractual terms in such cooperative ventures should be fair and reasonable and they should be in full compliance with the legitimate rights and interests of the parties concerned [as, for example, with intellectual property rights].
3. All States, particularly those with relevant space capabilities and with programmes for the exploration and use of outer space, should contribute to promoting and fostering international cooperation on an equitable and mutually acceptable basis. In this context, particular attention should be given to the benefit for and the interests of developing countries and countries with incipient space programmes stemming from such international cooperation conducted with countries with more advanced space capabilities.
4. International cooperation should be conducted in the modes that are considered most effective and appropriate by the countries concerned, including, *inter alia*, governmental and non-governmental; commercial and non-commercial; global, multilateral, regional or bilateral; and international cooperation among countries in all levels of development.
5. International cooperation, while taking into particular account the needs of developing countries, should aim, *inter alia*, at the following goals, considering their need for technical assistance and rational and efficient allocation of financial and technical resources:
 - (a) Promoting the development of space science and technology and of its applications;
 - (b) Fostering the development of relevant and appropriate space capabilities in interested States;
 - (c) Facilitating the exchange of expertise and technology among States on a mutually acceptable basis.

- [6. All States should pursue their activities in outer space with due regard to the need to preserve the space environment in such a way as not to hinder its continued exploration and utilization by present and future generations.]
7. National and international agencies, research institutions, organizations for development aid, and developed and developing countries alike should consider the appropriate use of space applications and the potential of international cooperation for reaching their development goals.
8. The Committee on the Peaceful Uses of Outer Space should be strengthened in its role, among others, as a forum for the exchange of information on national and international activities in the field of international cooperation in the exploration and use of outer space.
9. All States should be encouraged to contribute to the United Nations Programme on Space Applications and to other initiatives in the field of international cooperation in accordance with their space capabilities and their participation in the exploration and use of outer space.

E. Informal consultations on new items for the agenda

Unofficial background note by the Czech Republic

Review of existing norms of international law applicable to space debris

The purpose of the consideration of this proposed item would be to examine the problem of space debris from the perspective of existing international law which could be applicable to the phenomena of orbital debris. In this regard, the following questions should be examined:

Does the definition of "space object" as contained in the 1972 Liability Convention and the 1975 Registration Convention cover space debris?

Do provisions of the 1967 Outer Space Treaty concerning the avoidance of harmful contamination of outer space and adverse changes in the environment of the Earth apply to the problem of space debris?

Should the protection of ownership of space objects, and of their component parts, also be extended to space debris?

Should liability for damage caused to a space object and/or its crew by space debris depend on the proof of fault as in the case of a collision of two space objects?

These and other questions are of a legal nature and should be analysed and answered by legal experts.

The consideration of these questions would not amount to the drafting of new provisions but should serve to clarify the issues involved and help to improve the interpretation and application of the existing norms of international space law.

The time-frame for consideration of the suggested item could be limited to two sessions of the Subcommittee with the understanding that no more than two to three meetings would be devoted to it at each of these sessions. Thus the consideration of this item would not require any extension of the current duration of the Subcommittee's session.

F. Informal consultations on new items for the agenda

Unofficial background note by Chile

Comparison of the norms of space law and those of international environmental law

I. General background

Space technology has turned out to be one of the most efficient instruments for dealing with the problems which affect the environment. Various conferences and international treaties, both at the global and regional levels, have highlighted that link. Furthermore, the dramatic change in international relations has made itself felt by global strategic threats, among them, those concerning the environment.

With regard to international legislation, the most obvious consequence of the global change is the growing number of multilateral treaties covering new fields and realities which did not exist before or had not been discovered. It has brought about an interrelationship between the different components of the environment and the technological instrumentation (space technology applications) which cannot go unrecognized.

II. Justification of the item

The background presented creates the need to know in depth the features and central elements of both branches of international law. Not only because of their practical interconnection, but also because they reflect the "common concern of humanity" and, in many cases, the problems arise in a sphere which is the "common heritage of all mankind". Likewise, the destiny of present and future generations, within the context of sustainable development, is embodied, in a normative sense and with nuances, in the relevant instruments of space and environmental law.

An exact knowledge of the relevant dispositions and key ideas could facilitate the adoption of new conventions containing an all-embracing point of view or make possible a more precise legal interpretation of the existing instruments in tune with the global requirements.

III. Procedure to be followed

The schedule for the examination of this item could consist of the following stages:

- (a) A comparative study by the Office for Outer Space Affairs on the central points in both branches of law. In this study, the Office could be assisted by experts who could be provided by various delegations;
- (b) A request by the Secretary-General of the United Nations for information from Member States regarding national and international instruments to which they are party, and regarding the possibility of creating a common legal framework to serve as reference for broaching more efficiently the problems that "shall be the province of all mankind" (Article 1.1 of the Outer Space Treaty);
- (c) In the light of the above, the comparative examination proper could begin within the Legal Subcommittee without prejudice to the courses of action to be followed once the exercise has been completed.

G. Informal consultations on new items for the agenda

Unofficial background note by Mexico

Review of the status of the five international legal instruments on outer space

A review of the status of the international agreements relating to activities in outer space immediately reveals that many States have not ratified these instruments. As an indication, a table summarizing information on ratification of the individual instruments is given below.

	<u>Ratifications</u>	<u>Signatures</u>
1967 Outer Space Treaty	93	27
1968 Agreement on Rescue	83	25
1972 Convention on International Liability	76	25
1975 Convention on Registration	39	4
1979 Agreement on the Moon	9	5

Source: A/AC.105/C.2/1996/CRP.2.

This information is a matter for concern because it reflects the limited application of the legal instruments relating to outer space. The object of this proposal is preparation of a preliminary document compiling the opinions of COPUOS delegations on this situation, as well as consideration of the advisability of devising some kind of multilateral strategy to achieve a greater commitment of States to the existing legal instruments. New subjects such as the one covered by this proposal can be studied at the current session of the Legal Subcommittee.